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THE ANALYSIS OF CHANGES IN AGRICULTURAL SUPPLY: PROBLEMS AND APPROACHES[1]

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I. *Summary and Conclusions*

AGRICULTURAL supply analysis is not, strictly speaking, a neglected area in agricultural economics research. It has been a field of interest for more than forty years and is currently being pursued with greater vigor than ever before. Considerable attention has been given to what changes would be profitable for firms to make in relation to changes in product and factor prices. But somewhat less has been given to the changes they will and do make, especially in the context of the empirical testing and modification of theories of producer behavior.

A review of the research underway and needed in the area of agricultural supply seems desirable. Many of our present and proposed farm programs, policies, and educational activities reflect widely different views with respect to the nature of supply response in agriculture. Economic analysis can substantially reduce the role of "intuitive judgment" in appraising the effects of prices and other economic variables on output.

Further, improved supply analyses can provide basic contributions to the development of important related research areas. The development of several aspects of the analysis of "technological change" and of "agriculture

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[1] Misc. Journal Series Paper No. 1047, Minnesota Agricultural Experiment Station. This paper is a condensation of a research memorandum prepared for the Social Science Research Council Committee on Agricultural Economics and the American Farm Economic Association Committee on New Orientations in Research and presented to the Committees in October, 1959 (2). References have been added at several points to papers presented at the North Central Farm Management Workshop on Estimating and Interpreting Farm Supply Functions, Chicago, January 20-22, 1960 (20).

We are indebted to O. H. Brownlee, W. W. Cochrane, R. H. Day, H. O. Jensen, H. M. Southworth, F. V. Waugh, and R. L. Mighell and to members of the Committee for helpful comments on an earlier draft of this paper. Needless to say, responsibility for errors and omissions rests entirely with the authors.

Numbers in parenthesis refer to the bibliography appended to this paper.

in an economy of abundance," mentioned in an earlier report (12), will depend largely on supply research now underway or needed.

The objects of research on changes in agricultural supply include improving: (1) our understanding of the mechanism of supply response, (2) our ability to *forecast* supply changes, and (3) our competence to prescribe solutions to problems related to agricultural supply. All of these are important both at the level of individual farms and at various levels of commodity and geographic aggregation. Put another way, these are problems of how people actually behave and how they should behave to make the best use of resources available to them. These problems are interrelated; how one may best optimize depends upon how others behave. Further, when actual behavior departs from prescriptions for optimizing, questions are raised as to whether our theory of optimizing leaves out important aspects or whether it misjudges the goals of those with whose behavior we are concerned.

Supply or production response analysis is particularly needed currently because of the severe problems agriculture continues to face in adjusting supplies to market demands and the confusion existing with respect to the causes of these difficulties. Parts of the area are neglected and the failure of many to see the scope and nature of the subject as a whole has led to an unfortunate fragmentation in research and neglect of certain aspects of the field.

In this survey we attempt to set forth a brief theoretical scaffolding on which to array and evaluate recent contributions to agricultural supply analysis. At the heart of supply analysis lies the static production function of the individual firm, but uncertainty, flexibility of fixed factors of production, and changing technology modify the application of this concept. Furthermore, aggregation of individual firm supply responses is necessary before many results useful for policy and forecasting purposes can be derived. Recent work in the area of agricultural supply includes studies of production functions in the neo-classical vein and in the linear programming mode, budgeting and cost studies, and direct time-series supply analyses. Developments in the use of data from producer panels offer considerable promise. Special mention should also be made of recent work on the supply of agricultural products as a group.

Our survey suggests that several important gaps on the theoretical side exist. These are:

(1) An adequate theory of aggregation for firm supply functions. Houthakker's recent attempt (44) represents a start, but the model with which he deals is too simple to be applied directly to most agricultural problems and should be developed in greater generality. The implications of the level of aggregation on the fixity of factors and other conditions that shape supply response should also be explored.

(2) An adequate theory of behavior under uncertainty. Promising approaches in this area appear to be models based on modern statistical decision theory, further refinements in the notion of certainty equivalence, and the interesting rational expectations hypothesis which has recently been proposed by Muth (62).

(3) An adequate operational theory of investment for the firm, that is, an empirically useful theory of how so-called fixed factors are varied over time in response to economic and other forces. Although the controversy on capital theory appears to be over and substantial agreement on the theory of investment seems to have been achieved within the profession, the gap between theory and application is still wide. This is particularly true in agricultural economics. Recent developments in the theory of optimal inventory behavior (1) and dynamic programming (5) may help to close the gap.

(4) A theory of, or at least techniques for measuring, the diffusion of technological changes and their specific effects on the production possibilities open to the firm.

On the empirical side our main conclusions are that:

(1) Too few studies have been conducted in which supply functions have been derived from production functions of either the neo-classical or programming variety and no meaningful attempts have been made to aggregate such functions.

(2) The use of producer panels in supply analysis is an important new development. Not only may it provide immediate benefit in the form of increased forecasting accuracy, but it should provide an excellent testing ground for new developments in the theories of behavior under uncertainty and the variation of fixed factors over time.

(3) Much quantitative and qualitative research is needed on the markets for inputs in agriculture. Current analysis of the total supply of agricultural products may attribute too much to the influence of technological change and improvements in the qualities of factors of production within the agricultural sector.

(4) There is need for a combination of empirical approaches to the supply problem at all levels of aggregation between firm and industry. Direct time-series analyses for individual commodities or group of commodities need to be supplemented by studies of supply response based on programming and traditional production function analyses for groups of farms and geographical sectors of the national agricultural plant.

We would particularly stress that approaches at all levels, from the most aggregative to the most disaggregative, are complementary, not competitive. Work with time-series data for the nation and linear programming models for a typical farm in eastern Kentucky both contribute to our knowledge of supply, and both should be encouraged.

At the same time, there is need for capitalizing on this complementarity by attempting to bring together the relevant findings to form a picture of the total supply or production response, to develop some generalizations of the effects of price changes on supply over varying time spans, and to permit a better understanding of changes in combinations of productive factors, changes in technology, and uncertainty as they affect supply response. Finally, there is need for increased research emphasis in certain areas to "fill the gaps" that exist in our knowledge of various aspects of supply response.

II. *The Setting of Supply Analysis*

The basic theories of supply are useful for a variety of purposes. Most emphasis in agricultural economic research has been given to the type of technology and quantities of inputs that would maximize profits to individual farms at a point of time under the varying conditions that exist in agriculture. The emphasis in supply analysis is on the changes in production or supply that will take place through time as prices and costs change. This analysis makes use of the same basic supply theories, but time is explicitly considered and the final emphasis is on what farmers as a group will do through time with specified changes in costs rather than on what they would or should do individually to maximize net revenue in a timeless context. In this non-normative and dynamic context, considerable attention must be paid to theories relating to risk and uncertainty, fixity of factors, and economic growth. A convenient starting point, however, remains the elementary theory of the firm and the static supply function.[2]

1. *Production possibilities of an individual firm*

A basic datum for all agricultural supply analysis is a summary of the technological possibilities for transforming inputs into outputs and for substituting one output for another and one input for another. This summary, which we term the *production function,* may be either explicit or implicit in the analysis, but it is always present in one way or another. The conventional production function of economic theory is generally expressed as an implicit functional relationship between all outputs and all variable inputs; i.e.,

$$f(y_1, \ldots, y_n; x_1, \ldots, x_m) = 0, \tag{1}$$

where $y_1, \ldots, y_n$ are quantities of outputs and $x_1, \ldots, x_m$ are quantities

[2] In this context, we mean by static supply function one which does not involve time in any meaningful way. The moment a supply function is specified to hold for a given period of time, the analysis has been imbedded in a dynamic context, although this context may not be explicit. Real economic processes, of course, do involve time in a meaningful way, but this fact does not detract from the utility of static constructs in organizing our knowledge and directing our thinking.

of inputs. Equation (1) may generally be solved for any one of the outputs, say y_1, in terms of all the other outputs and the inputs. In the case of one output, it may be solved for the quantity of that output, y, in terms of the inputs:

$$y = g\,(x_1, \ldots, x_m). \tag{2}$$

The production function is frequently defined in relation to given fixed resources. If a barn, for example, is considered to yield not a variable flow of services, but a fixed flow which cannot be augmented if need be or reduced if use of such services is not required, then the services of the barn do not enter g or f as variable inputs. Both g and f are defined given such fixed service flows.

Given a production function for the firm of the form (1) or (2) and information on the nature of the relationships involved, it is possible to derive functions expressing outputs, costs, and derived demands for inputs in terms of given prices of the outputs and inputs.[3]

The classical approach to the production function has been treated in an excellent exposition by Carlson (13). An expository discussion of the more recent programming approach to production is given in Dorfman, Samuelson, and Solow (19).

The programming approach to production makes direct use of large amounts of detailed technical data, whereas the more traditional approach typically assumes such information to be implicitly incorporated in the form and parameters of the production function. Although both the programming and traditional formulations are cut from the same theoretical cloth, differences in the way the two are applied are quite marked.

2. *Dynamic aspects of supply*

We turn now to the modifications which uncertainty, flexibility of fixed factors over time, and technological change may make in the foregoing analysis.

Technological change and the learning process.[4] The rate at which technological changes occur, the rate at which changes are adopted, and the effects of such changes upon factor combinations and output levels are little understood. Such changes, if they are adopted, alter the underlying conditions of production upon which all supply analysis is ultimately

[3] A derivation for a simple form of the production function is given in the appendix to our original memorandum (2).

[4] A more general discussion of the problem of technological change is contained in the memorandum, "Research on the Economics of Technological Change," submitted by Vernon Ruttan to the Committees of the SSRC and AFEA to which previous reference has been made. This problem was considered a key one by many of the participants at the North Central Farm Management (NCFM) Workshop (20); see especially the opening paper by E. O. Heady.

built. It may well be that we will never be able to understand fully the course of invention and discovery and hence the rate at which basic technological developments become available. The rate at which technological changes are adopted and their effects on the production process, however, are more amenable to economic analysis. Much work has been done on the effects of technological changes on output and income.[5] But relatively little analysis has been made of the rate at which these technologies are adopted, and especially how this rate has been related to changes in price.

Through technological advance more output can be obtained with the same total resources; alternatively, fewer resources are required to produce the same output. On the surface, the changes that occur from technology are rather clearly distinct and separable from the changes arising from recombination of inputs and products. There are, however, difficult problems of definition and of interrelationships with static supply analysis and the "prior maximization" assumptions.

These problems are illustrated in figure 1. With the present technology for producing products x and y, a fall in the price of x relative to that of y will change the optimum combination produced from point A to point B. With a new technology, represented in the diagram by the curve on which points D and E lie, an identical price change results in a shift of the optimum from D to E. But suppose the firm is not perfectly efficient, as is the case with most real-life firms because of a lack of knowledge or reluctance to make needed investments, and is producing at point C. How the firm will change the combination of x and y produced, given its present non-optimal position and simultaneous changes in prices and the technical possibilities, is a significant question in the analysis of production response. An answer is likely to depend on the nature of the temporal relationship between the firm's actual position, usually non-optimal, and the position which would at present be optimal given the present, or anticipated future, price relationships and technological possibilities. Thus the answer appears to require an understanding of how firms acquire knowledge of the possibilities open to them and their optimal positions, and how firms determine the path along which they should move toward their optimal positions as they presently understand them. The former is a learning process, the latter is formally identical to the investment process.

Diffusion of new technology depends in part upon reduction of uncertainty concerning the probable results of adoption and in part on the

[5] Among the studies of this type see: Barton, G. T., and M. R. Cooper (3); Cooper, M. R., et. al. (16); "Agriculture's Capacity to Produce" (79); Hearings, Study of Agricultural Economic Problems of the Cotton Belt (80); Johnson, N. W. (51); and Loomis, R. A., and G. T. Barton (59).

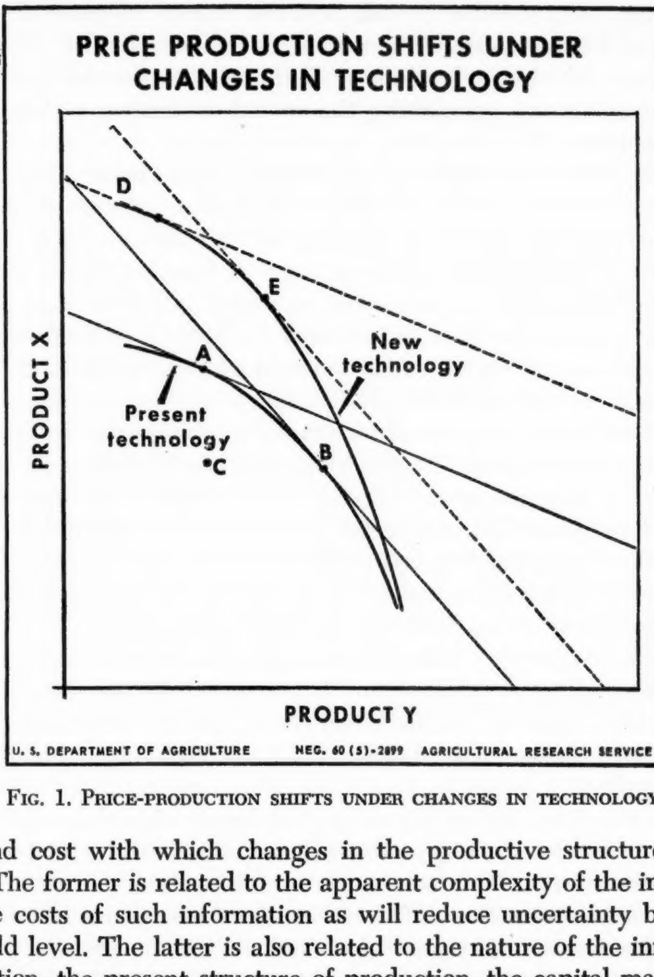

FIG. 1. PRICE-PRODUCTION SHIFTS UNDER CHANGES IN TECHNOLOGY.

ease and cost with which changes in the productive structure can be made. The former is related to the apparent complexity of the innovation and the costs of such information as will reduce uncertainty below the threshold level. The latter is also related to the nature of the innovation; in addition, the present structure of production, the capital market, and other markets which connect the firm to the outside economy are important.

Despite the great complexity of this problem, substantial progress appears possible. Some promising starts toward empirical application have been undertaken in both the learning and investment areas. In a recent article on hybrid corn, for example, Griliches (22) has suggested a simple hypothesis that will account for the changing proportion of total corn acreage planted with hybrid seed. The "ceilings," or the points at which the proportions for different areas reach a maximum, are determined largely by the relative profitability of hybrid compared with open-pollinated varieties. The time at which adoption commences depends on

the "supply" of a suitable hybrid. And the rate of adoption depends on factors which affect farmers' acceptance of new technology. The frame of reference which he develops is likely to prove useful, with appropriate modifications, in injecting the spread of existing technology into supply analysis.

Flexibility of the so-called fixed factors. Fixed factors of production, which form the basis for the traditional distinction between short-run and long-run supply and are taken as given in both the neo-classical and the programming formulations of the production function, are in reality not fixed for all time but can and will be varied in response to economic forces. Investment in fixed factors may be limited or modified by the presence of uncertainty. Even in a world of perfect certainty, the imperfect second-hand markets and high relocation costs for durable factors of production mean that not all factors will be completely variable in the short run. Unfortunately, the empirical application of theories of investment, i.e., of variation in fixed factors of production over time, is not at all well developed. This is especially true in the agricultural sphere.[6]

One possible approach to this problem derives from the work of Glenn Johnson (47). It may be characterized as follows: From assumptions about the technology of farm production, institutional factors in the markets for inputs, and maximizing behavior, it is possible to build up a model of the behavior of an individual firm that accounts for the structure of its assets and its supply of products over time. Then by suitable aggregation of firms with various characteristics one can build up a picture of industry supply.[7]

Lerner (57, pp. 334-38) has suggested broadening the theory of the variation of fixed factors of production, and hence of the long and short runs, by introducing the idea that changes in input levels are costly and that they are more costly the faster they occur. Consider a farmer, for example, who expands dairy production and contracts hog production when the price of dairy products rises relative to pork prices. His expansion of dairy production is limited in the short run by fixed facilities for milking and housing cows. Some modifications in his dairy plant can be made quickly at little cost; but a doubling of milk production might require entirely new facilities. If the farmer invests at once in the new facilities, his capital costs will, of course, be higher, but to such costs we must also add a surcharge, the price the farmer must pay for increasing his fixed factor so quickly. This cost occurs for a variety of reasons, among which

[6] Glenn Johnson has stressed this point in much of his recent work; see (47), (48) and his paper presented at the NCFM Workshop (20).

[7] A very simple illustrative example of this procedure is contained in Nerlove's paper presented at the NCFM Workshop. This example shows the extreme importance of the aggregation problem.

are: (1) The higher interest he must pay in an imperfect capital market for borrowing funds rather than financing his investment through profits, and (2) the inefficient method of production that must be adopted because older items of equipment are in use alongside the newer. Given a longer period of time over which investments can occur, the financing of such investments will tend to be less costly and the investments themselves will tend to be more productive.

Finally, it should be noted that the use of distributed lags in aggregate time-series supply analysis is essentially a very simple way of incorporating those aspects of supply related to the fixity of resources.[8] The use of such simple models has been quite correctly criticized on the grounds that the model is not at present founded on an explicit microtheory of behavior nor are the results obtained with such models capable of easy comparison with the results of studies of the behavior of individual firms.[9] It should be noted, however, that what work as has been done on this question suggests that such simple models may need to be modified only slightly in order to make them more readily applicable.[10]

Expectations and uncertainty. One of the chief problems in the empirical application of economic theory is that of specifying the correct, or at least a useful, relation between the constructs of the theory and the variables which can actually be observed. In time-series supply analysis one form of this problem is that of specifying the relation between observable events and the prices which farmers expect to receive for their outputs and expect to pay for their inputs.[11] In the production of almost all farm commodities, inputs must be committed to a greater or lesser degree some time before output is realized. A farmer must therefore base his plans not on what he is currently receiving or has received in the past, but on what he thinks he may receive in the future. What a particular farmer thinks, or better what farmers as a group think, on the average, is what is relevant to farmers' supply decisions, and is therefore the relevant theoretical construct for supply analysis. But what farmers think is a subjective matter and not directly observable over long periods of time; hence,

[8] See especially Griliches (24) and (27), Halvorson (29), Nerlove (64) and (65), and Nerlove and Addison (68).

[9] Johnson (48) and (49).

[10] See Nerlove (66, Note 5, pp. 74-96) in which a simple dynamic model of production is developed that incorporates hypotheses with respect to the "costs" of input changes. A different model more closely related to Johnson's approach is discussed in Nerlove's paper presented at the NCFM Workshop. This model shows that the smoothing effects of aggregation may offset the type of discontinuities that Johnson suggests are important in the case of the individual firm.

[11] Another such problem, which we do not discuss here, is that of the relation between *planned* and *realized* output, e.g. the effects of weather on crop yields. For a substantial stride forward in handling this problem see Stallings (75).

we are faced in supply analysis with an extremely difficult problem of the general type discussed here.

Uncertainty raises a further difficulty. In agriculture it has been discussed primarily in connection with farm management problems.[12] It is clear, however, that if uncertainty affects how farmers *ought* to behave with respect to investment, farm organization, and production plans, it must also affect how they *do* behave, although perhaps in not quite the same way. This is just the other side of the economic coin. In this light, uncertainty raises issues for supply analysis which go beyond the problem of relating theoretical constructs to observable variables. Technological developments, changes in market organization and structure, and government policies have altered the impact of uncertainty upon supply decisions. However, the problem of most immediate concern remains the one first mentioned; without some sort of workable solution to this problem, the other elements cannot be brought into the picture in a truly meaningful way.

A basic and useful theoretical construct in this connection is the notion of certainty equivalence.[13] In the certainty equivalent to a problem of decision making under uncertainty, each uncertain variable is replaced by one or more variables the values of which, if expected with certainty, would lead to the same solution as that which would be obtained by treating the decision problem in its full generality. This notion underlies all time-series supply analysis, although not always explicitly. Models of expectation formation are essentially methods of arriving at certainty equivalents for uncertain future prices. Empirical studies at the microlevel of farmers' expectations and the relationship of these expectations to their plans could be improved if more explicit consideration were given to the concept of certainty equivalence. In this way, a closer connection could be developed between farmers' decisions at the microlevel and aggregate supply response over time.

3. *Aggregation of static supply functions*

The problem of aggregating supply functions for individual firms and single commodities into supply functions for groups of firms and groups of commodities has been explored mainly from a theoretical point of view. Theil (76) has developed what may be called a "statistical" approach to the problem of aggregation which may be characterized as follows: Suppose we are given a microtheory (in this case a theory of the individual firm's supply) and some simple aggregates of the microvariables

[12] See, for example, Johnson and Haver (50), and North Dakota Agricultural Experiment Station (69).

[13] See Hildreth (43). The paper by Nerlove presented at the NCFM Workshop also discusses this concept at some length.

(in this case sums of output levels and input levels, if we are aggregating over firms, or indices, if we are aggregating over commodities). We assume a macromodel analogous to the micromodel, which relates the aggregates (e.g., an industry supply function). Now we estimate the macromodel statistically and ask what the meaning of the estimated parameters is in terms of the parameters of the microtheory. In particular we ask how the estimated parameters differ from simple combinations of the microparameters, such as sums or averages.

Theil's approach to the aggregation problem may be quite useful in examining the consistency of supply analyses based on aggregate time-series data with research on farm or firm production functions and the individual firm supply functions which may be derived from them, but it suffers from two serious defects from our point of view: First, it does not permit us to use information on individual supply functions directly to deduce, support, or modify aggregate supply analyses. In a sense, the macrorelations are less "real" for Theil than are the microrelations. Second, Theil's approach does not take into account that the macrorelations may be of a fundamentally different character than the microrelations. Such differences in the character of macro- and micro-relations are fundamentally due to the presence and unequal distribution of fixed factors and technical knowledge among firms, and to institutional differences.[14] Less fundamental differences are encountered in practical problems involving comparison of results or combination of data for time-series and cross-section studies.

III. *Current Research in Supply Analysis*

Two general approaches may be used to attack supply problems empirically: (1) constructive methods which involve the derivation of supply functions from data and information relating to production functions and individual behavior, and (2) statistical analysis of time-series data.

1. *Constructive methods*

Classical production functions. A great deal of research in agricultural economics has been devoted to the study of production functions.[15] Much of this work is closely tied to the technological aspects of particular types of enterprises; almost all of it has been directed to answering questions of farm management, and we find few examples of systematic synthesis of

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[14] Houthakker (44) gives a useful discussion of aggregation in a special case. Following his approach in broad outline, more explicit attention is given to estimation problems in the appendix to Nerlove's NCFM Workshop paper.

[15] A large number of references are cited in Heady, Johnson, and Hardin (37). More recent studies include Beringer (6) and surveys by Heady, (32) and (33).

supply functions from estimated continuous production functions.[16] The development of continuous production functions from available farm management data is a possible approach to supply analysis. However, in the estimation of production functions from farm records or survey data, one encounters three major difficulties:

(1) Interfarm differences in managerial input and in technology;

(2) Multiple products which are interdependent in production; and

(3) Measurement of input levels, particularly capital.[17]

Little attention has been paid to interfarm differences in technology, but a good deal of thought has been devoted to the problem of differences in managerial input. Griliches (21) has spelled out what effects differences in managerial input, if omitted from a production function analysis, may be expected to have on the estimates of the parameters in the function. Attempts to include some measure of managerial input have generally proved unsuccessful. Glenn Johnson's suggestion for selecting the sample to remove intercorrelations between input levels and the residuals of the fitted producion function is a device for skirting around the problem of managerial input,[18] as is the use of simultaneous equations techniques.

The problem of interdependent multiple products is closely related to the problem of managerial input. As Beringer (6) has pointed out, if *all* relevant inputs to a series of productive processes can be identified and measured, there is no reason why production functions cannot be estimated for the various productive processes independently. For many types of inputs such tagging may be possible in principle although extremely difficult in practice. In the context of developing continuous production functions for various enterprises, the services of a barn, for example, might in principle be allocated among the various productive activities to which it contributes, but extremely detailed knowledge would be necessary in order to make this allocation anything less than completely arbitrary. Further, managerial input is one which in principle cannot be divided among various activities, for in essence it consists largely in deciding at what levels various activities will be carried on, in what combinations, and with what techniques. This fact alone suggests

[16] Although there have been some attempts to synthesize supply functions from linear programming production functions; see below.

[17] See the papers by Glenn Johnson, French, and Beringer in Heady, Johnson, and Hardin (37, pp. 16-23, 90-113). A more detailed survey of these problems is given in E. W. Kehrberg's paper presented at the NCFM Workshop.

[18] However, inasmuch as least-squares techniques tend to bias the calculated residuals towards randomness, Johnson's technique may fail to remove significant interdependence between residuals and independent variables. Hence, use of special samples to correct a condition which causes the estimates to possess undesirable statistical properties may not be effective even though it may appear to be so. A different way of looking at management is not to regard it as an "input" at all, but rather as the ability to choose appropriate production functions and levels of activities. See Nerlove (67).

that very few studies which assume independence in production will provide useful descriptions of multiple product firms.[19]

The problem of measuring input levels (and output too) is a difficult one. The problem of capital input is particularly troublesome. Not only does capital consist of a tremendous variety of things, but capital input cannot be measured by the *stock* of capital. It should be measured by the *flow* of capital *services* used. The flow of services need not be related uniquely to the available stock of capital because of the existence of excess capacity, and even in some cases of what might be called "deficit" capacity.[20]

Farm budgeting. Farm budgeting was developed to avoid some of the problems of allocation inherent in classical cost and production functions. The construction of synthetic supply curves by means of farm budgeting was suggested by John D. Black in a research handbook in 1932 (8). The first actual use of this method as a tool of supply analysis was in a series of studies of supply response in milk production, done in the years following Black's suggestion and summarized in 1951 in a volume by Mighell and Black (61).

Linear programming can now be used to do precisely the same job, provided it is used in a larger analytical framework dealing with such factors as the rate of adoption of new technology and the like which have heretofore required the personal judgment of the investigator. In the budgeting procedure, a distinction was made between the *most profitable* and the *most likely* organization. After determining several alternative setups and finding the *most profitable*, further judgment was used to consider what would be *most likely* to happen under the assumed conditions. It is the output in the *most likely* circumstances that enters the synthetic supply schedule. The *most likely* circumstances embody judgment about how rapidly new technology is adopted, how farmers react to risk and uncertainty, and similar factors. Thus the procedures of Mighell and Black involve a great deal of personal judgment. The personal judgment of the investigator must, of course, enter at some point in every study of

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[19] As indicated earlier, the classical approach to production functions in economic theory is to specify the production function as a single implicit function relating all inputs and outputs. A function of the Cobb-Douglas type cannot be used to relate aggregate quantities of *several* outputs to aggregate quantities of several inputs. See Klein (53, p. 227). If one could assume independence of the productive activities and could tag all the inputs, one could employ the Beringer approach and use individual production functions for each enterprise, although from the standpoint of economic theory this is unnecessary and possibly undesirable. Another possibility might be to represent the production function by a system of equations relating each output to the totals of the various inputs employed in all enterprises. This last approach would be a good way to avoid simultaneous-equation difficulties if it could be assumed that inputs were definitely committed in advance of production.

[20] See Griliches (28).

this type, particularly if conclusions of immediate practical significance are desired.

In a linear programming approach to supply analysis reported by McPherson and Faris (60), for example, a milk supply function is constructed for a single farm. Instead of points on a curve, vertical lines indicate ranges of indifference within which the organization may not respond to a price. To carry this kind of price mapping forward to an aggregate supply curve for an area or group of farms, it would be necessary, at least in the present state of the science, to introduce similar judgment as to the *most likely* output for each farm and to consider other factors operating in the area, as in the farm budgeting approach.

It must be recognized that for any treatment of supply response, elements of judgment enter the problem. Judgment enters first in setting up assumptions, it enters last in interpreting results, and it is likely to enter at various points in between. The important thing is to reduce the area of judgment to a minimum and to formalize it wherever possible.

Linear programming production functions. In recent years, linear programming techniques have been widely applied to production economics.[21] As noted earlier in this paper, linear programming assumes a special sort of production function and concentrates on resource limitations. Nonetheless, programming has much to offer to supply analysis. Given the production coefficients, linear programming procedures enable relatively rapid testing of the effects of price and cost changes on the "optimum" production of alternatives.

The device of programming with variable prices, or price-mapping as it is sometimes called, is discussed by Heady and Candler (36, Chapter 8). It is simply the derivation of a supply function for the individual firm from a linear programming production function. Concrete applications of the technique to derive firm supply functions have been made by Knutson and Cochrane (54), Toussaint (78), McPherson and Faris (60), and Tompkin (77).

A major aggregation problem exists in linear programming, as in the budgeting approach. It is perhaps intensified because of the sensitivity of the optimal programs to the available levels of fixed resources. Work on the aggregation of firm supply functions is still in the early stages and much remains to be done. Plaxico (71) has presented a comprehensive discussion of approaches to these aggregation problems and to the problems of moving from "optimum" to actual responses that are encountered in deriving an empirical sector supply function by linear programming analysis.

2. *Statistical analysis of supply based on time-series data*

Direct time-series analyses have actually involved fitting greatly sim-

[21] Heady and Candler (36) contains numerous references.

plified supply functions to aggregate data. There are a great many such studies both for crops and for livestock products.[22]

Aggregate time-series analyses of supply are not subject to some of the aggregation problems discussed in the preceding section. Such analyses deal directly in the magnitudes which are of interest in making policy decisions, such as total quantity produced or total acreage and national average price. For various statistical reasons, however, it is possible to introduce only a few of the variables which are relevant, and this, in a sense, is a special aggregation problem.

The fact that only a few of the relevant variables can be introduced in time-series analysis of supply constitutes perhaps the greatest single limitation of the approach. In addition, substitutability and complementarity among inputs and outputs cannot be adequately measured, nor can the effects of changing technology be properly separated from changes in the combinations in which inputs are used and outputs produced. Furthermore, history is not always the best of laboratories; information related to the possible effects of a new government program or new techniques of production may simply not be available from the historical record.

Of particular importance in aggregate time-series supply analysis are the dynamic problems discussed above: (1) Uncertainty and expectations, (2) the flexibility of "fixed" factors over time, and (3) the problem of changing technology. Recently all three of these problems have been under close scrutiny.

As indicated above, despite its limitations the notion of certainty equivalence is basic to time-series supply analysis. However, certainty equivalents need not be directly observable; hence, simple models of expectation formation have been developed to relate expectations to observable variables. The simplest of these are the extrapolative models of which the use of one or more lagged prices is a special case. Somewhat more complex are "adaptive expectations," which have recently been used by Nerlove (63) and (65), Hee (40), and others. Still more complex are "rational expectations," recently proposed by Muth (62).

Both extrapolative and adaptive expectations are subject to a number of well-known theoretical and practical difficulties. Furthermore, Ladd (56, p. 454), has pointed out that simple expectation models of this form are not directly applicable to livestock and livestock products. He argues that because gestation and production periods cover several seasons, "the current output of livestock products depends on decisions made in more than one period and on expectations concerning present price that were formed during several periods." In his discussion of the cattle cycle,

[22] Many recent studies have been summarized by Dale Knight in a paper presented before the NCFM Workshop. Summaries for some of the older studies for crops are contained in Nerlove (65, pp. 66-86).

Breimyer (10) also makes clear the great complexity of any livestock enterprise: Supply decisions can be made at many different points in time and decisions at many previous points in time affect current alternatives. Recent results of Dean and Heady (18) tend to support the conclusion that simple expectational models of the type used in analyzing crop supply are not directly applicable to the analysis of the supply of livestock products. The same complexities which make this proposition true for livestock products are, to be sure, true to a certain extent for crops; but the difference in degree is so great that an entirely different approach may be required for livestock products. One promising avenue is to approach the question of livestock supply as a modified inventory problem. Substantial new developments have taken place in the inventory field in recent years;[23] adaptation of existing techniques for handling inventory problems may well produce useful models for analyzing livestock supply. In addition, rational expectation models may be expected to be highly useful in this connection.

From the standpoint of economic theory, the rational expectations hypothesis is the most attractive formulated to date which is sufficiently simple to be used in connection with time-series analysis. Stated in concise form, the rational expectations hypothesis is that ". . . expectations, being informed predictions of future events, are essentially the same as the prediction of the relevant economic theory."[24] Thus rational expectations can be derived only within the context of a particular economic model, but for this reason they possess the property of being entirely consistent with it. In particular, greater rationality in the basic model than in the model of expectation formation is not assumed. No empirical applications of this hypothesis have yet appeared, but we feel that it holds great promise.

The problem of fixed factors and investment has been handled to date by means of simple distributed lag models. Such models are subject to a number of practical difficulties and problems of interpretation. Alternative approaches are suggested in the previous section; to these we should add the methods adapted from inventory theory just mentioned in connection with livestock.

The aggregation problem which arises in time-series supply analysis relates primarily to the difficulties involved in including relevant variables. Analysis of supply for relatively small geographical areas offers a partial solution to this problem. The competitive relationships among crop and livestock enterprises are extremely complex on the national level. Alternatives to a particular crop or livestock enterprise are more limited

[23] See Arrow, Karlin, and Scarf (1), especially Chapters 1 and 2.

[24] Muth (62, p. 1). Arguments for this superficially unreasonable hypothesis are presented in Nerlove's Workshop paper. An example of how such expectations may be derived is also given.

in smaller areas. Hence, a statistical analysis of supply for a relatively small area can include more of the relevant variables than can an analysis for a larger area. However, other factors, such as changing technology and institutional environment, can be handled no better on a regional than on a national basis. Furthermore, when we are done with our regional analyses we still have to put them together to provide the comprehensive information on supply that is required for most practical problems.

Cochrane (14) and Schnittker (72) have emphasized the role of technology in shifting agricultural supply functions and have incorporated this factor in analyses explaining past supply behavior. Cochrane's research, in particular, has played an important part in directing the attention of agricultural economists to the role of new technology in shaping supply response to price. As is the case with most new ideas of such scope, personal judgment enters Cochrane's analysis extensively and at many levels. Emphasis in subsequent research should be on reducing the area of judgment and on more detailed studies of the way in which particular technological changes have affected supply.

3. *Combination of time series and constructive approaches*

In recent years, consumer panels have been developed, largely by private enterprise, for the measurement of the effects of advertising and price policy. A number of familes are paid to keep accurate accounts of their expenditures on a wide variety of goods and services. An attempt is made to keep the sample the same or nearly the same over long periods of time. Thus, a body of data is built up describing the same households over time. The dynamic effects of advertising and of changes in income and price can be analyzed with such data.

Similar studies can be made for producers. One such for Ohio farmers is reported by Tompkin (77). Adjustments of farms to changes in grain and livestock prices were analyzed, as were changes in factor combinations. Tompkin's report covers only a two-year period, but the study is expected to continue for several more years. Day, Jensen, and Sundquist are undertaking a similar sort of study for dairy farms in Minnesota. Questions on their schedule include some on future plans as well as on expectations. In both studies, sufficient information is collected to construct estimates of the changes that would be optimal in the context of changing price and cost relations. It may be possible, therefore, to analyze the relation of plans to expectations and the relation of plans to actual behavior and to compare actual behavior with that considered to be optimal.

The device of a producer panel offers special promise in the field of agricultural supply analysis. It is necessary that such studies be undertaken and extended if we are to apply and test the theoretical developments related to uncertainty and other dynamic problems recommended earlier in this paper. Further, the subject of reservation demand, i.e., the

demand of a farmer for his own output,[25] can perhaps best be studied on this level, as can many of the sociological factors which affect supply. Needless to say, the existence of a number of strategically located producer panels will greatly improve forecasting accuracy, particularly of the effects of policies which have no historical counterpart.

Adaptation of linear programming to develop a dynamic system which would enable prediction over time is urgently needed. Recent studies in this direction have been made by Henderson (42), who has developed a system of constraints for short-run forecasts of acreage by linear programming. In a study in the Mississippi Delta area, R. H. Day[26] is currently attempting to generalize Henderson's approach to a more explicitly dynamic system and to apply it to yield as well as acreage changes. The Day study also separates fixed factors and technological change for separate treatment. The basic programming formulation is retained but additional constraints are imposed on the shift of resources from one activity to another over time. The empirical content of these restraints is derived largely from time-series data. An important question that must await further empirical testing is the applicability of the basic formulation at the level of area aggregates and sub-aggregates.

Recent research undertaken by Loftsgard and McKee[27] supplements the Henderson-Day approach at the microlevel by attempting to build the institutional constraints on farm credit, capital formation, and capital disposal directly into a programming model. Thus, they are more explicitly concerned with the *causes* of resource constraints than are Henderson and Day.

Synthetic supply functions based on some sort of programming analysis modified to include dynamic elements offer substantial promise, particularly if sufficient attention has been paid to the problem of aggregation. But it should be recognized that for many purposes supply functions for representative firms represent only a step in the derivation of an aggregate supply function.

4. *The total supply of agricultural products*

Most agricultural economists would agree that the problems involved in understanding the supply of any particular agricultural commodity are secondary compared with the problem of understanding the supply of agricultural products as a whole. This is not merely because the problem is a larger one, but also because it is in some sense more fundamental, more closely related to the problem of agriculture in the American economy and to the problems of agricultural policy.

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[25] Reservation demand is perhaps less important in shaping supply response in a developed economy such as the United States than it is in the economically underdeveloped areas of the world. But it is highly important in these areas.

[26] Reported in a paper at the NCFM Workshop.

[27] Reported in a paper presented at the NCFM Workshop.

If we knew perfectly the way in which the supply of each of the many hundreds of products produced in the agricultural sector was determined, the interrelations among these supplies, and the way in which to aggregate this knowledge, the problem of total supply would be solved. Until the day we know so much has come, however, the problem of total supply will continue to be qualitatively different in many ways from the problem of the supply of any particular commodity.

Factors such as improvement in the quality of inputs, changing relations between the agricultural sector and the rest of the economy, the functioning of the farm labor market, and even technological change may play far less of a role in shaping the supply of a particular commodity than they do in shaping the supply of farm products as a whole. Whereas we may be satisfied with simple trends in analyses for single commodities, the ignorance which such trends measure becomes intolerable when we consider all commodities.

Recent discussions of the total supply function have emphasized the role of technology and improvement in the quality of inputs, particularly the labor input, almost to the exclusion of other aspects.[28] As important as these factors are, changes in the way in which factors are combined, changes in the markets for farm inputs as prices change, as well as the increasing scale and specialization of farms, decreased uncertainty, and the like must also be considered.

Recent findings with respect to the variation in inputs associated with changes in farm income and business conditions emphasize the importance of such factors in affecting farm output trends. Hathaway (30) has indicated that there are definite relations between changes in farm income and expenditures for nonfarm inputs and between changes in business conditions and farm output. Loomis and Barton (59), in an analysis of the recently completed index of agricultural input, find a relation between the rate of change in inputs and both farm income and business conditions. The changes in income and business conditions, however, have usually modified the rate of change rather than direction of the trend in resource use. More research is needed to quantify the effects of changes in resources used on production in a dynamic context.

Knowledge of the static supply function is a first step toward understanding total supply. From the production possibilities of the farm sector as a whole we may derive the total supply function and the derived demand functions for inputs. These functions form a static interdependent set of equations for the farm sector, related to one another and to the underlying conditions of production. Griliches (25) has outlined an approach for deriving the total supply function from knowledge of the derived demands for inputs. His total supply function shows the relationship

[28] See Cochrane (15) and the debate between Heady and Schultz (73), (34), (74), and (35).

between some aggregate concept of supply of the agricultural sector and some aggregate concept of the price of agricultural output *given the prices of inputs*. Griliches' work, though admittedly crude, shows clearly the relationship between studies of input demand and supply analysis.[29]

Factor prices cannot be expected to remain constant as agriculture expands or contracts; hence, research on the supply functions for inputs to the agricultural sector is needed to complete the picture. Gale Johnson (45), Glenn Johnson (47), and Heady (31), have all stressed this facet. All three have examined several hypotheses about factor supplies and production possibilities to arrive at relatively qualitative knowledge of the total supply function for agriculture. Quantitative work on factor supply functions is only beginning and is hampered by lack of data. At a recent meeting of the American Farm Economic Association, papers were presented on the markets for farm machinery, fertilizer, and commercial feeds;[30] these papers are useful in calling attention to factors affecting the supply of these inputs. This type of research should be pursued, hopefully in a quantitative direction. The farm labor market has been studied quite carefully in recent years but without great success.[31] Though we are far from quantitative understanding, Bishop's use of linear programming to determine farm-nonfarm allocation of family labor (7) suggests a way to better knowledge at the microlevel.

Analysis based on index numbers for aggregate farm production and prices received is unsatisfactory for many policy purposes. Attempts at some disaggregation while still maintaining an aggregative outlook are valuable adjuncts, therefore, to the study of total supply. Disaggregation in this sense appears in the application of input-output models to agriculture[32] and the work of Cromarty on the development of a complete structural model for American agriculture.[33] Input-output analysis by itself, while an extremely useful descriptive device, does not appear to offer much promise as an analytical tool in supply analysis because of the rigid assumption on the nature of production possibilities which it involves. Cromarty's work, however, strikes us as more worthwhile analytically. Not only does it disaggregate total supply while maintaining an aggregative point of view, but it will eventually serve as a base for tying together our knowledge on much less aggregative levels.

Technological change and improvements in factor qualities are important shifters of static supply functions over time at the aggregative level. These have resulted in the continued upward trend in output even during

[29] Recent studies of input demand include those of Griliches (23) and (24), and Heady and Yeh (39) on fertilizer, and Cromarty (17) and Griliches (26) on tractors and other farm machinery.

[30] Phillips (70), Baum and Clement (4), and Brensike (11).

[31] See especially in this connection the paper by Gale Johnson (46).

[32] Heady and Schnittker (38).

[33] Reported in Bonnen and Cromarty (9).

extended periods of reduced farm incomes. In this connection, Sherman Johnson and Bachman have shown that in the context of rapid technological change additional investments have been highly profitable at current price levels, and would probably continue so even with considerably lower prices (52). This suggests that in understanding changes in total supply, emphasis needs to be placed on studies of the learning and investment process. Important aspects of the total supply problem we would stress in this context include: The variability of "fixed" factors, which Glenn Johnson has emphasized, and reduced uncertainty, which Gale Johnson has emphasized. It seems to us, however, that many of these hypotheses can be studied in brighter light on a less aggregative level than that of the total supply.

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COORDINATION AND VERTICAL EXPANSION IN MARKETING COOPERATIVES[1]

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AGRICULTURAL marketing cooperatives are feeling the impact of the changing structure of the food market. The importance of traditional marketing channels is being reduced due to direct buying and other procurement practices used by major purchasers of food products, particularly large retail chains and groups of independent stores. In addition, marketing cooperatives are being called upon to assume a new relationship to their producer members. Changes in technology and organizational structure at the farm level have led to increasing emphasis on the producer cooperative as an instrumentality through which farmers can secure for themselves the advantages of new production and marketing techniques.[3]

There is evidence that nonfarm firms, such as suppliers and processors, exert increasing influence over farm activities through various contract or other integrating techniques. This has prompted agricultural and cooperative leaders to promote the increased utilization of cooperatives to accomplish the desired integration. The implications of this expanded use of the cooperative form of business organization are many. As marketing cooperatives are called upon to provide more services for their members, such as production credit, minimum price guarantees, additional processing and marketing facilities, and more expert field services, certain problems inherent in cooperative organization may assume considerably more importance than they have in the past.

The widespread use of the cooperative form of organization by farmers testifies to its successful performance in the past. However, the current trend in agriculture toward expanded use of the cooperative organization in numerous unfamiliar roles requires closer study of some aspects of this form of organization. It is the author's view that certain unique features of cooperative structure must be given specific attention by cooperative leaders in making their expansion plans.

Adjustment of marketing cooperatives to today's changing conditions

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[1] Giannini Foundation Paper No. 191.

[2] Views expressed are those of the author.

[3] See, for example:

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U. S. Department of Agriculture, *Contract Farming and Vertical Integration in Agriculture* (Washington: Govt. Print. Off., 1958), 21 p. (U. S. Dept. Agr. Info. Bul. No. 198.)

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gives rise to two types of problems: First, there are those that involve the internal relationships and operations of the existing functional organization and, second, those specifically related to the vertical expansion of the cooperative.

Internal Adjustment Problems

Problems internal to existing organizations include the following: (1) coordination of member practices with market requirements, (2) centralization versus decentralization, and (3) charges for services to members.

Coordination of member practices with market requirements

The degree of control exerted by a marketing cooperative over the production practices of its members varies widely from one organization to another. But in virtually all marketing cooperatives, the achievement of the proper coordination between producer-member practices and market requirements is a continuing problem. Standardization programs often involving brand-name promotions, payment procedures, and other incentive systems have been widely used to attain this goal, but they have frequently met with limited success.[4]

The retail orientation of the food market is reflected in narrowed specifications based upon the requirements of self-service supermarket merchandising. Retailers indicate that uniformity of products, stability of supplies, and continuous availability of adequate volumes are of the utmost importance under today's conditions.[5] Elements of the marketing chain below the retail level must consider these requirements and adjust their operating techniques so as to fill them to best advantage.

There are some fundamental aspects of the cooperative form of organization that affect its ability to adjust to these conditions. Although relatively little has been published concerning the basic nature of the members' relationship to the cooperative and to each other, students of cooperation who have ventured into this field, such as Emelianoff, Robotka, and Phillips, have been in general agreement on certain important points. They point out that the individuality of the cooperative member is maintained and each carries on his operations in such a manner as to pursue his own economic objectives. In this pursuit he includes the cooperative function as an extension of his operation. The member's decisions are based upon his individual situation, and these are reflected in the operations of the cooperative.[6] The marketing cooperative, as opposed to the purchasing

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[4] Collins, Norman R., and John A. Jamison, "Mass Merchandising and the Agricultural Producer," *J. of Marketing*, 22: 365-66, April 1958.

[5] *Ibid.*, pp. 362-63.

[6] Emelianoff, I. V., *Economic Theory of Cooperation* (Washington, D. C.: 1942), pp. 248-50.

cooperative, depends upon its members for the major inputs with which it operates. The product offered for sale is directly related to the operations of the individual member. In view of these considerations, problems of coordination seem to be inevitable.

The assurance of independence of operation for member firms has been a major factor in the growth of many marketing associations to positions of great size and importance. There is a significant difference between voluntary adherence to cooperative grades, standards, and other regulations, as is practiced in most of the large marketing associations, and compulsory compliance with established specifications. It is also noteworthy that control of grades, sizes, volumes of shipments, etc., often have eventually come under some type of state or federally enforced marketing order in California, where marketing cooperatives are considered to be relatively strong.[7] This has occurred even when the members of a single cooperative have produced from 75 to 90 per cent of the total state production of the commodity.

The ability of marketing cooperatives to control quality, size, and other product attributes dependent upon member production practices cannot be judged simply on the basis of the framework for vertical integration which they provide. The fact that cooperatives are made up of individual firms each pursuing its own objectives may be of extreme importance in cooperative integration. To the extent that each member unit is guided by the same considerations in choosing its production practices, the operations of the cooperative may well reflect these coordinated actions of its members. However, it is hard to visualize even the most outwardly homogeneous group of growers of the same product as having identical policies and practices in relation to the cooperatively marketed product.

For regional cooperatives, this problem is more complex. The divergence of interests discussed above refers primarily to the membership of local associations or centralized marketing cooperatives. The typical federated regional cooperative has local associations as its members. These local associations reflect the characteristics of their membership, which are often difficult to coordinate toward a single objective. The central sales organization must coordinate the objectives of each local in its relationships with the succeeding level of the marketing system. Common problems faced are those concerning equality of treatment of member associations; guarantee of delivery to fulfill sales contracts; comparability of grading, sizing,

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Robotka, Frank, "A Theory of Cooperation," *J. Farm Econ.*, 29: 113, Feb. 1947.
Phillips, Richard, "Economic Nature of the Cooperative Association," *J. Farm Econ.*, 35: 74-76, Feb. 1953.

[7] Mueller, Willard F., "Vertical Integration Possibilities for Agricultural Cooperatives." (Paper delivered at a joint annual meeting of the American Marketing Association and the American Farm Economic Association, Philadelphia, December 29, 1957.) p. 9. (Processed.)

and other processing operations; standardization of brands and packs; and variation in packing, storage, processing, freezing, and other physical facilities.

Centralization versus decentralization

The problem of centralization versus decentralization has long been prominent in large-scale business organization, and it recurs frequently as an organization grows or as industry conditions change. There are three general types of centralization: centralization of authority, of functions, and of performance or location.[8]

Location and functions. Centralization of location in the organization of a regional marketing cooperative is usually governed by the location of the various member locals. Centralization of functions such as accounting and bookkeeping, legal and insurance services, purchasing, research, advertising, and other staff operations is often accomplished through regional marketing organizations. Local cooperatives, however, frequently fail to take full advantage of the savings available in centralizing many of these functions through their central organization. Basic to their failure in this regard may be their assertion of independence. Although many locals look to the central marketing cooperative for advice and assistance in relation to functional problems, they are often reluctant to turn these functions over to the more specialized departments of the central. This may stem from the desire to keep their internal affairs to themselves in order to be in a position to withdraw easily or to use withdrawal as a "threat" to obtain better service from the central, or simply from an historical precedent of relationships with the central. On the other hand, the central organization may avoid adding this type of service, in a formal sense, to its functions, preferring to minimize its responsibilities to its local members in order to reduce the possibility of internal friction.

Whatever the reasons for the existing degree of centralization of functions, present conditions in food marketing call for careful consideration of economies that could be achieved through centralization of appropriate functions. Such centralization implies improvement of communications and reports between the central and local and probably extensive revision of certain historical relationships. The traditional independence in many intracooperative relationships may greatly reduce the possibility of achieving the advantages claimed for vertical integration through cooperatives.

Responsibility and authority. It is in the area of centralization and decentralization of responsibility and authority that the greatest adjustments

[8] Petersen, Elmore, and E. Grosvenor Plowman, ***Business Organization and Management*** (Chicago: Richard D. Irwin, Inc., 1945), Chap. 9.

Spriegel, William R., ***Principles of Business Organization*** (New York: Prentice-Hall, Inc., 1946), pp. 66-67.

seem to be needed. The central marketing association is in a position to assume responsibility for a large number of decisions that fall naturally into its sphere of operations. Efficient business organization dictates that decision making gravitate to those best qualified for it. According to Herbert A. Simon, "To gain the advantages of expertise in decision making, the responsibility for decisions is allocated, so far as possible, in such a way that decisions requiring particular knowledge or skill will rest with individuals possessing that knowledge or skill."[9]

The recent rapid development of vertical integration in agriculture, principally as developed through "contract farming," indicates the importance of centralized responsibility and authority for decisions involving coordination between production and marketing operations. A principal advantage of most of these integrating arrangements is the centralization of decision making concerning matters that are of vital importance to the operation as a whole. Decisions relating to these aspects are centralized at that level of the organization where the "knowledge or skill" concerning their application to the total enterprise is located.

Here, again, the independence of operations of cooperative members, both individuals and locals, makes it difficult to exploit the foregoing advantages of integration. Centralization of responsibility and authority for decisions at the proper level means, in the case of a central marketing cooperative, that those decisions that affect the sales functions of the business should be centered with the management of the sales organization. The scope of this group of decisions has broadened significantly during the past few years as buyer specifications have become more detailed and rigid and vast changes in packaging and processing technology have occurred. Hence, many more decisions now require "knowledge or skill" –possessed by the central marketing cooperative–and the responsibility and authority for these should be reallocated accordingly.

While the type of decisions considered above should be centralized, there are valid reasons why authority and responsibility for other decisions which directly affect local-area operations should be allocated to the local level. In many fields, such as meat packing, fruit and vegetable packing and shipping, and poultry processing, there seems to be a definite trend for buyers to deal directly with local units concerning many details of the purchase. In the fruit and vegetable industry, the increasing prominence of the independent grower-shipper may be a result of this.

Mass merchandising requires increasingly detailed specifications of product, pack, shipment, delivery, and other matters of consequence to the buyer. Many of these specifications require a close relationship between

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[9] Simon, Herbert A., *Administrative Behavior* (2d ed.; New York: The Macmillan Co., 1947), p. 137.

the retailer and the producer or first handler. The scale of operation of many large buyers has made it feasible to organize procurement departments or to engage procurement agencies to fulfill this need. Certain arrangements for purchase and shipment under these circumstances can most easily be made at a local level with those who actually handle the product. As a direct consequence of this trend, some aspects of sales responsibility and authority are shifting from centralized sales specialists to the managers of physical handling operations.

Central marketing associations can choose their own local representatives with this broader function in mind; however, they often have little control over local member-association management. Effective coordination through marketing cooperatives can be reduced by a local association management that is not oriented to the total marketing program. This problem is inherent in the local autonomy that is historically characteristic of a federated cooperative's local associations. Decentralization of certain marketing functions makes it increasingly important for central marketing organizations to participate in the training of local managers and to encourage the selection of managers who are able to fill a much broader post than that often envisaged by local association members.

Charges for services

Today's changing marketing conditions often require cooperatives to increase the number of services to members and customers. New, more specialized departments and personnel, additional field supervision and member advisory services, increased personal communication internally and externally, added informational services, and new or enlarged research functions may be necessary. These additional services lead to increased expenditure, hence higher charges to members.

If charges assessed by the marketing cooperative have been relatively stable per unit of sales (dollar volume or physical unit) for a long period, any appreciable change requires complete membership understanding. If, even in view of increasing operating expenses, the cooperative has been able to maintain a relatively constant percentage of savings due to increased volume or increased selling prices, any sharp increase in expenses and reduction in savings can become a major membership problem. If the membership is not homogeneous in its operations, any abrupt change in services and charges may require extensive explanation and reconciliation of conflicting member opinions and interests. In view of this situation, needed additions to services in adjustment to changing marketing conditions are often made slowly, if at all. This problem can be partially overcome by assessing charges for services rendered only against members utilizing them. Local associations using a central cooperative's accounting,

traffic, or other departments should pay in accordance with use. Field services are usually not uniform to all members, and this should be reflected in charges. Grading costs for members' products vary widely due to quality and variety differences, and charges should be assessed accordingly. Selling costs for some varieties and grades of products are much greater than for others, and this should be reflected in charges as closely as possible.

If the cooperative moves vertically to other levels of the distribution system, these service-charge problems tend to intensify. Here, again, it is assumed that a marketing cooperative's membership is not usually homogeneous in its size of operation, practices, financial standing, or even products produced. Unless all members can take equal advantage of the expanded services, such as extended production credit and additional processing or selling facilities, the costs involved should be carefully allocated to those using these services.

Major Vertical Expansion Problems

As a cooperative expands vertically, particularly toward the consumer, three of the major problem areas faced are: (1) increased capital requirements; (2) increased time between harvest and ultimate sale of product; and (3) increased remoteness of the management from the membership. Some of the principal considerations in each of these areas are indicated separately; however, they are closely related.

Increased capital requirements

Control of the cooperative organization is limited to the members who utilize the services that it provides. The cooperative is not considered an investment opportunity.[10] Although many cooperatives have excellent credit ratings and can readily obtain loan capital or sell nonvoting preferred stock, the member patrons of the organization are the sole source of risk capital of the common-stock type. Loan capital involves fixed interest rates and rigid repayment schedules. Preferred stock usually requires regular dividend payments at its designated rate or at least a cumulative feature if it is to be a ready source of capital. These inflexibilities can become

[10] Among the many publications which have considered these issues are the following:

Bakken, Henry H., and Marvin A. Schaars, *The Economics of Cooperative Marketing* (New York: McGraw-Hill Book Company, Inc., 1937), Chap. 6.

Erdman, H. E., and J. M. Tinley, *The Principles of Cooperation* (Berkeley: Feb. 1957), 32 p. (Cal. Agr. Expt. Sta. Bul. 758.)

Nourse, Edwin G., *The Legal Status of Agricultural Cooperation* (New York: The Macmillan Company, 1927), pp. 21-24.

Idem, "The Economic Philosophy of Cooperation," *Amer. Econ. Rev.*, 12: 577-97, Dec. 1922.

substantial burdens when cooperative earnings are reduced due to short crops, unfavorable market conditions, or other operating problems. Any expanding firm may be prone to develop an unbalanced capital structure due to the fact that it is generally easier to sell preferred stock or obtain loan credit than to procure equity financing, such as through sale of common stock.[11] The restriction of the risk capital market to members of the cooperative increases the danger of developing this unbalance.

Faced with this limitation in obtaining outside capital, cooperatives must consider the possibilities of their members financing expanded operations. To the extent that expansion can be financed by retaining savings made in the cooperative operation, it can be argued that the member is in reality only leaving his "extra" earnings in the cooperative. Of course, this is only true if the member has not invested other capital in the organization at an earlier date, and in any case the "opportunity cost" of these earnings should be considered. If expansion requires members to invest additional funds in their cooperative, it will become important for the cooperative investment to be weighed against other alternatives, either on the farm or in diversified investment opportunities.

Return on investment in cooperatives, as opposed to investment in noncooperative, corporate enterprises, is not measured in such a manner as to allow direct comparison with other alternative investments. In view of the psychological and other nonpecuniary benefits of cooperative membership, this problem of measurement of return on investment has not loomed large in marketing-cooperative finance and accounting. Facilities have usually been relatively minor when measured against total volume of business done and the total farm investment of producer members. However, as cooperatives grow and expand into major forms of investment for the members, it would seem that some more exact measures of return on this investment become necessary.

If marketing cooperatives are not to be considered as investment opportunities, independent of the farm operations of the members, then they must be viewed as an extension of the farm operation. Under these conditions, the investment made in the cooperative should be weighed in much the same manner that on-farm investments are weighed, that is, in relation to expected contribution to the earning capacity of the enterprise. It is difficult, if not impossible, for cooperative accounting records and financial statements to provide information upon which the member can base such decisions. Analyses of the effects of vertical expansion upon the financial positions of the individual members of cooperatives would be highly desirable, but they are seldom available.

[11] Guthmann, Harry G., and Herbert E. Dougall, *Corporate Financial Policy* (2d. ed.; New York: Prentice-Hall, Inc., 1948), pp. 488-489.

Increased time between harvest and sale

As the cooperative moves its services closer to the consumer, such as to include processing, wholesaling, or even retailing, the grower member must necessarily continue his ownership interest in the product for a longer period. This requires increased operating capital and a possible extension of market risk.

This aspect of vertical expansion by cooperatives seems to be opposed by an apparent tendency for growers, particularly younger or expanding growers, to seek firm prices for their products at as early a stage in the marketing chain as possible. As on-farm capital requirements grow, the risks inherent in farm operations assume larger proportions. Mortgage financing is needed and fixed repayment schedules dictate close attention to cash returns, both as to timing and amount. Recent studies of vertical integration in agriculture have pointed out that some of the principal reasons given by farmers for entering into integrating arrangements were to assure themselves of a firm price and to shift the market risk to someone else.[12] While it is true that cooperative membership provides a "home" for the member's product, the sales transaction is not consummated until cash is received from an ultimate buyer.

Growers who have become well established and financially sound are often willing to accept the risk possibilities associated with cooperative efforts to obtain the "last dollar" from products handled. Less well established farmers, particularly younger members, who must build their operations with assets (land in particular) valued at current prices, are more likely to settle for a lower risk factor and a known return sooner. Cooperative membership relations, hence operating success, can be gravely endangered by the failure of management and directors to appreciate the diverse circumstances of the members. This problem may be particularly important if the board of directors, as is so often the case, is made up of long-time members well established in their farming operation and probably relatively strong financially.

Marketing cooperatives seek quality producers, good cooperators and, in general, competent operators. However, strong financial standing is a membership qualification which is becoming more and more important. This is due to the increased member investment required as vertical expansion proceeds, and the additional operating capital needed by the members and the association as the cooperative controls the product farther toward the consumer before a cash sale is made. There are many farm-

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[12] Collins, Mueller, and Eleanor M. Birch, *Grower-Processor Integration* (Berkeley: October, 1959), 77 p. (Cal. Agr. Expt. Sta. Bul. No. 768.)

U. S. Department of Agriculture, *Contract Farming and Vertical Integration in Agriculture, op. cit.*, p. 4.

ers, particularly younger and expanding ones, who may stand high in the other qualifications for cooperative membership but are likely to be foreclosed from cooperative membership due to increasingly stringent financial requirements.

Increased expansion of cooperatives made up of members financially strong enough to afford the additional costs involved may leave a large group of producers to be "controlled" by nonfarm interests on various levels of the distribution system. Many of the advantages claimed for farmer control of their marketing channels through cooperatives could be materially weakened under these conditions.

Remoteness of management

In today's specialized business community, operations on each level of the marketing chain require highly trained management. This management is necessarily concerned with competing successfully with noncooperative operations on the same level and maintaining satisfactory interlevel relationships. At succeeding stages of the system, buyer-seller negotiations are increasingly influenced by consumer-oriented merchandising considerations. Central selling organizations are frequently condemned by members or local association managers for being too lenient or too "soft" in relationships with buyers. This feeling is likely to be magnified as the product moves farther from the producer.

Cooperative directors are producer members who have a direct, personal interest in the operations of their organization. This production orientation is one of the major strengths of the cooperative form of organization; however, it is a two-edged sword. Cooperative directors are usually among the most successful producer members of the organization. As such, they are proven successes in their chosen occupation—farming. Most directors are the first to admit that their skills are different from those required by the management they choose for their organization. Even at the local association level, it is difficult to find successful managers who have been chosen from the membership of the local board.

As the scope of the organization grows vertically and the cooperative's activities move away from the grower level, the management skills required necessarily become broader and the management team must include more specialists. Cooperative boards are well aware of this and usually seek ways and means to fill this need. However, as this development occurs, the directors themselves become less and less able to perform two of their vital functions: close supervision of management's performance and advising and assisting management on policy matters. Whereas many noncooperative corporations competing directly with cooperatives include on their boards specialists in fields which have important bearing on

company operations, such as finance, law, administration, and accounting, the cooperative is usually foreclosed from this type of board. The direct interest of the board members as representatives of the membership is a basic reason for the utilization of the cooperative form in agriculture. However, the ability of such a board of directors to oversee an increasingly remote and specialized management and to act in an effective advisory capacity to that management also deserves close attention if an existing strong organization is not to be weakened as vertical expansion proceeds.

Conclusion

The views expressed in this paper are based on the author's belief that the cooperative form of organization has distinct characteristics which in many cases make it admirably suited to the uses made of it. However, these same characteristics seem to lessen its adaptability to other uses. As new and different organizational techniques come into increased use in agricultural production and marketing, cooperatives must carefully review their strengths and weaknesses.[13]

Successful existing cooperatives provide important guidance in this regard; however, it is difficult to appraise the role of cooperatives in a rapidly changing industry on the basis of past performance. Large, successful cooperatives are often pointed out as examples of what cooperation has done for particular groups of producers. Although there are certainly practical advantages in patterning future cooperative plans on past successes, it is of crucial importance that the reasons for these successes be carefully appraised. Many of the frequently cited examples of highly successful marketing cooperatives owe a large measure of their success to specific circumstances surrounding their formation and early growth. Marketing conditions which preceded their formation were often such as to necessitate vast improvement of physical facilities, information and communication, and other specialized services which were not being adequately provided.

It is equally difficult, if not dangerous, to look to noncooperative firms performing functions contemplated by the cooperative for guidance in expansion planning. The specific differences between the cooperative and other forms of organization may well be crucial to success or failure. Research in agricultural cooperation can be a strategic factor in the adjustment of marketing cooperatives to today's changing conditions. However, the research approach should include consideration of the fundamental

[13] Many relevant strengths and weaknesses of cooperatives are discussed in the following publications:

Erdman, "The Commodity Cooperative Association—Its Strength and Weakness," *J. Farm Econ.*, 6: 106-16, Jan. 1924.

Idem, Possibilities and Limitations of Cooperative Marketing (Berkeley: 1925, rev. 1942), 19 p. (Cal. Agr. Expt. Sta. Circ. 298.)

characteristics of cooperation as a form of business organization and the exploitation of the strengths which are inherent in it. Equally important is recognition of the apparent weaknesses of cooperatives and increased emphasis on methods for overcoming these weaknesses or definitions of the limits that they place on cooperative expansion.

At the first session of the American Institute of Cooperation, in 1925, H. E. Erdman said, "Successful cooperation must be based on a definite, feasible purpose. Cooperation based on the abstract belief that everything should be done cooperatively is not on safe ground."[14] This statement deserves as much, if not more, consideration today.

[14] *Idem*, "Some Economic Fundamentals of Cooperation," *American Cooperation, 1925* (Washington, D. C.: American Institute of Cooperation, 1925), p. 70.

A FRAMEWORK FOR RURAL DEVELOPMENT*

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THROUGH the Rural Development program[1] American society has articulated its discontent with full reliance on "the market" in the task of allocating resources and distributing income in the course of the nation's economic development. In this modest effort to remedy low-income conditions, society has presented agricultural economists greatly expanded opportunities for education and research in economic development and public policy. This paper presents a conceptualization of the program which aims at clarifying the task and the opportunity.

Two provisions of the program are relevant to the development of such a framework. One is that major effort in Rural Development is to be made by local people. The second is that the effort should be comprehensive in scope. This raises two questions. (1) How much control can local people exercise over the development of their area? (2) How can this control be accomplished? This framework will enable us to seek answers to these two questions, although it does not supply the answers.

The Decision Complex

To answer the question of how much control local people have over the development of their area, we must focus on the social determinants of economic development. Social determinants consist of those arrangements imposed by man upon environment. Natural or physical resources set broad limits to economic development, but as technology is developed—through man-made arrangements—nature submits to human control. This vast wilderness of the American Indian became the world's most developed country under European institutions adapted to the resource patterns. One of history's dramatic social arrangements, the Manhattan project, has yielded one of our great energy sources, atomic power.

These arrangements, resulting in forces determining economic development, stem from arbitrary decisions. Our government did not have to grant land for colleges or for railroads. It did not have to gamble billions on

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[1] United States Department of Agriculture, *Developing Agriculture's Human Resources,* Washington, D. C., 1955.

atomic energy. The decision to preserve the Union required the Civil War to implement it. These decisions are real forces for economic development. They help determine how resources are to be exploited, who is to be remunerated for the exploitation and to what extent, to what use the resources will be put, even the quantities of the resources themselves.[2] These arrangements interact with each other and with the physical and natural resources to give us the end product, our economy today. In Rural Development we are now expecting local people to devise social arrangements to bring about economic development.

Decisions resulting in social arrangements for any given area are made by some kind of an entity which represents the public. For any given situation, the decision-making entity finds certain forces impinging on economic development that are not under its control and certain ones that are. These forces can be classified as *autonomous* and *volitional.*

Autonomous forces, from the decision maker's viewpoint, are *self*-propelled and *self*-guided. They are impersonal, immutable forces over which he has no control. Economic development which results from such a force is called *autonomous* development.

From the decision maker's viewpoint, he can take purposive, deliberate action aimed at a definite end based on his volition only. This decision is a *volitional* force. Economic development resulting from volitional forces is called *induced* development.[3] Induced development involves intellectual activity, a decision with the specific objective of economic development. Rural Development aims to induce development locality by locality.

Some autonomous forces can be predicted to a certain extent but cannot be controlled by the decision maker. Some autonomous forces are fortuitous. They cannot be predicted. They are windfalls. Volitional forces are subject to both control and prediction by the decision maker.

Each decision maker must classify forces into autonomous and volitional for every situation. The classification changes either when the decision locus changes or when time changes. The formula for distribution of state funds to schools is an autonomous force to the local school corporation. It is a volitional force from the viewpoint of the General Assembly, which established the formula and can change it at its volition. What was volitional at one time becomes an autonomous force at a later time. The public road facilities of the present, an autonomous force, are a result of volitional action taken in the past. Even though a new decision can be made, a

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[2] See Erven Long, "Some Theoretical Issues in Economic Development," *J. Farm Econ.,* 35: 723 (Dec. 1952).

[3] Of this same concept Hoselitz writes, "Alterations of social institutions by the elite . . . may be designated as a process of induced or planned change." Bert F. Hoselitz, "Non-Economic Factors in Economic Development," *Amer. Econ. Rev.,* 47: 40 (May 1957).

facility built or a debt incurred remains as an autonomous force.

Using this conceptualization to view the Rural Development situation in its entirety we must also classify decision-making entities according to the decision locus as federal, state, and local. The decision-making entity at each of these levels must consider autonomous and volitional forces, and both autonomous and volitional forces at one level become autonomous forces to lower levels. Thus the amount of influence which local volitional forces can exert is circumscribed. This concept can be shown graphically. Figure 1.

Type of Force	Decision Locus		
	Federal	State	Local
Autonomous	X →	XX →	XXX
Volitional	X	X	?

FIG. 1

This diagram illustrates that of all classifications of forces influencing economic development of an area only one admits of local influence. But it does admit that one. Society at all levels can take volitional action to change situations.

This simple conceptualization has two uses. It helps the local decision maker place its situation in perspective. It separates the problems which can be solved locally from those which cannot be. Omitting this classification, the decision maker spends effort in attempting to control autonomous forces and at the same time overlooks certain volitional action open to it.

It also helps policy makers and program planners at each decision locus to formulate the problem they face. The present program, placing almost the entire burden for Rural Development on local effort, is under question on this very point of where volitional effort is to be applied. Schultz, in laying out the problem in 1949 and building the case that poverty in agricultural was a public rather than a private responsibility, suggested the federal government in a direct action program give financial help to enable people to move out of low-income areas to the industrialized centers, providing the expense be non-recurring.[4] He mentioned nothing of local effort. He re-emphasized his position seven years later in "Homesteads in Re-

[4] Theodore W. Schultz, "Some Reflections on Poverty in Agriculture," *J. Farm Econ.*, 31: 1112-13 (Nov. 1949).

verse."[5] Ruttan and McDermott have maintained that in the attitude toward local effort lay the strength and also the weakness of the Rural Development program.[6] In every one of the last several sessions of Congress bills have been introduced to supply federal funds for industrial development to low-income areas. So far none have become law.

The Decision Maker

To the extent that local influence is adequate in low-income area economic development we are still faced with the question of how this local force can be activated. Several questions are involved. (1) Just who or what is the local decision-making entity? (2) How is an idea requiring local action which is conceived in the nation's capital communicated to the local decision-making entity? (3) How are decisions to be made locally in view of the fact these local configurations up until now have apparently not made adequate decisions?

Rural Development implies that some local entity has the power to take volitional action in the public or collective interest. Such is not the case. Local units of government in the United States have been delegated minor legislative prerogatives limited to specific narrow areas. Almost no provision is made for local coordinated legislative activity. In Indiana, for example, special legislation was required to enable a city and county to do planning and zoning together and even yet the local legislative functions are clearly separate. For any comprehensive effort no local legal management entity exists. Any successful Rural Development program, then, will have to look to creating some sort of management entity to perform the function of comprehensive decision making. Further consideration of this point must await conceptualizing of the communication channels between federal government and the local area.

The sociological concept of the "social system" is useful in conceptualizing this communication task. Of the social system Loomis writes:

> The fundamental datum for the sociologist is interaction. . . . Interaction can develop uniformities over time and hence become systematized by the structuring of actions. Structure refers to the established patterns of interaction that tend to persist. . . . In other words behavioral systems emerge out of interaction and we call these social systems.[7]

The Nation is a social system with certain attributes, one of which is the

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[5] Theodore W. Schultz, "Homesteads in Reverse," *Farm Policy Forum*, Vol. 8, No. 5 (Summer, 1956), pp. 12-15.

[6] V. W. Ruttan and J. K. McDermott, "How Effective is Rural Development?" *Farm Policy Forum*, Vol. 11, No. 1 (Summer, 1958), pp. 25-31.

[7] Charles P. Loomis, *Systemic Sociology—Essays on the Persistence and Change of Social Systems* (Princeton, N. J.: D. Van Nostrand, forthcoming), Essay 1. A behavioral system can be a family, a department, a professional association, or any other persistent grouping of people.

value placed upon equality of opportunity and income among its various segments. Systems within this system can be identified. One is the local or county system. Another is the United States Department of Agriculture—Land-Grant College system. The Rural Development program is a case of linking these systems together in a process Loomis calls systemic linkage, which is "the process whereby the elements of at least two systems come to be articulated so that in some ways they function as a unit."[8]

> A given individual may and usually does occupy status-roles in several systems at the same time. . . . By virtue of these concurrently held memberships the actor constitutes a 'living link' between systems. There are many types and forms of systemic linkage especially in directed change in which a change agent or social system attempts to bring about a change in a target system. . . . To understand social and cultural change, it is necessary to understand how agents of change link themselves to the target systems which are to be changed.[9]

In the Loomis jargon, the USDA-LGC system is the "change agent," and the county or local systems are the "target systems." The change agent in this case is really a complex of social systems,[10] and each has created an advisory social system within the county social system. The Rural Development program provides for horizontal articulation of these systems at all levels providing an identifiable USDA-LGC system.

The target system is made up of the people from whom action is expected, but still another system is involved. It is the Rural Development Committee, which is the decision-making entity. This system will concentrate or even generate the volitional forces in the local system for *induced* economic development. It will become an instrument of the USDA-LGC system. And it must be created and maintained. It does not exist naturally and is not a natural grouping.

An interesting aspect is that even though the solution to the low-income problem does not lie in agriculture, an agricultural system is being used for this task of linking the nation to the local system. This is likely simply a matter of expediency, since no other well-defined channel exists between the federal government and local areas.

We can now bring our attention again to the local entity for decision making, the newly created Rural Development Committee, a new social system. Building this new system presents two problems—selection of members and development of this aggregation of people into a social system with a definite pattern of interaction.

Members of the newly-created system will reflect the local system, while

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[8] Ibid.

[9] Ibid.

[10] This complex includes the Land-Grant Colleges, the Federal Extension Service, and the other agencies such as the Soil Conservation Service, the Farmers Home Administration, the Agricultural Stabilization and Conservation Administration, the Farm Credit Administration, and the U. S. Forest Service.

the USDA-LGC system will reflect the more rational characteristics of the nation. These differences will be compromised in the dynamic processes by which the new system becomes a system, i.e., establishes its specific ends and means, devises its leadership pattern and status and roles, and develops its techniques. Both parent systems will influence these internal dynamics, but the USDA-LGC system must avoid making too much of the conflict over these points. The new system must not move too far from its local parent in its beliefs, sentiments, ends, and norms, or it loses its value, even though from the USDA-LGC system viewpoint it is easier to manipulate and more comfortable with which to work.

So far, the extension services of the land-grant colleges are expected to supply the leadership for the USDA-LGC system. And land-grant social scientists occupy strategic positions in the Rural Development program since it hinges on social determinants of development, which is the property of the social scientist.

To understand the situation in which the land-grant college social scientist finds himself, one must look briefly at the nature and evolution of the land-grant college. It has won its reputation largely through increasing technological efficiency of the individual enterprise. Rural Development, on the other hand, aims at increasing in some manner the efficiency of a total area, and it involves the "acceptance of a practice" by a public which makes but one decision in which all wants must be reconciled. If several school corporations are reorganized, all citizens have to accept the decision. If land is zoned for specific purposes, all must accept it. If an extra health nurse is employed, all must pay for it. If it is decided the county agent should work on increasing non-farm opportunities, 4-H clubs and agriculture will receive less attention.

If county agents are to learn how to work in this manner, it will be up to specialists in the social sciences to teach them. Rural Development involves developing programs tailor-made area by area, not merely acceptance of a program. Although low-income areas appear similar, they differ in resources, in potentials for industrial development, in levels of leaderships, in public facilities such as roads and schools, and in many other ways. What Johnson says about management illustrates the nature of this problem. He writes, ". . . the managerial tasks must be repeated for each problem. Thus the manager . . . repeats the . . . tasks . . . without the acquisition of personal capacities or skills having repetitive values. . . ."[11]

The upshot of this is that the Rural Development Committee must be something more than a means of making efforts of extension workers go further. It must be in some way an analytical, decision-making group

[11] Glenn L. Johnson, *Managerial Concepts for Agriculturists,* Kentucky Agr. Exp. Sta. Bull. 619, Lexington: University of Kentucky, 1954, p. 14.

which can make plans in the public interest. It is not a legal public group but rather a *quasi-public* group. If extension services earn the leadership role entrusted to them they must make certain adjustments. Some of these are underway in the normal evolution of Extension but, by and large, they are just barely so. In these adjustments the extension services will look to the social scientist for leadership.

(1) Extension will have to broaden perspective, looking beyond individual firm problems to problems of public organization and management, problems involving aggregations of people, in which one man's welfare depends on another's actions and decisions and in which conflicting interests will be involved. It will likely also for a time at least have to broaden its interest beyond agriculture.

(2) Extension will have to be willing to concern itself with the very institutional framework, not simply with adjustments within it. Institution in this sense refers to such rules, habits, and expectations as state aids to education, federal aid to education, state policies of buying land, federal farm lending policies, and methods of taxation.

(3) Extension will have to develop a problem-recognition, management ability on the part of its clientele rather than simply to work only on "felt needs." This is not to deny the concept of "felt needs" nor to deprecate the local program development activity now going on in Extension. Rather it is to assert that definition of a problem or decision as to appropriate action is often a more difficult task than getting action once the appropriate action has been defined. Problem definition and decision on program may be Extension's greatest contribution. A myriad of action agencies, both federal and state, exist and are ready to act when they get the appropriate request. This task calls for familiarity with sociological and political processes of organization, group analysis, and decision making as well as competence in economic content. The essence of induced economic development is *public volition*. The process by which it is possible for a relatively small group to concentrate the motivations of the people of the area, weak as they may be, into a comprehensive program is not understood, if indeed such a process does exist.

The Decision Making

So far we have (1) conceptualized the range of efficacy of the local decision, and (2) illuminated the task of creating an effective decision-making entity and maintaining effective communication with it in order to get done the job society wants done. Now we are faced with conceptualizing the process by which the newly created decision-making entity makes decisions.

The conceptualization of management used by farm management re-

searchers is a useful starting place. Of this concept of management, Johnson says,

It is because knowledge is imperfect or changes imperfectly foreseen that it is necessary to perform the five managerial functions. A large percentage of the problems created by change and ignorance and encountered in running a business are not representative in nature. Such problems occur but once and the managerial tasks must be repeated for each problem.[12]

The five tasks of management he refers to are: (1) Observation, (2) Analysis, (3) Decision, (4) Action, and (5) Acceptance of responsibility.

Johnson includes perception of a situation or problem in the management function. "The envisioning of problems involves concepts of what ought to be"—i.e., a problem does not exist until reality appears to differ from what it is believed it should be.[13]

Three modifications are necessary in adapting Johnson's conceptualization to a much more unstructured management situation in which the management entity is some sort of collectivity, the management problem is of public rather than individual interest, and the goals of management are both vague and comprehensive.

The first modification concerns the perception of a problem. In management of a firm, perception of what is and what ought to be is relatively simple. In a public management situation, especially one concerning inducing economic development, the task of deciding just what ought to be may in itself be quite complicated. This involves what kind of school system should be provided, what level of income is desired, what kinds of roads are necessary, how many new jobs are needed, how much control over use of land is needed and many others. The perception of a problem itself perhaps results only from applying the management process.

The second modification concerns the knowledge situation, which Johnson says is a subjective definition. When a group is involved, how is a "subjective" definition made? To arrive at group decisions, some objectifying of definitions would seem to be necessary. Failure to make subjective considerations explicit interferes with intra-group communications to the point that concern with the tasks of management makes little difference. The conceptual framework for public "management" then must point up the need either to develop means of making subjective considerations objective or to make do with subjective considerations.[14]

The third modification of the individual management conceptual framework has to do with the acceptance of responsibility. The management

[12] Ibid. p. 14.

[13] Ibid. p. 7.

[14] Lindblom maintains that we'll have to make do with subjective definitions. See Charles E. Lindblom, "The Science of Muddling Through," *Public Administration Review*, Vol. XIX, No. 2 (Spring, 1959), pp. 79-88.

entity in Rural Development, a special group, does not assume responsibility for its actions in the same way the individual manager does. It will not lose money nor will it profit directly from the decision. It assumes responsibility through indirect effects on each member, through acclaim or criticism from others in the larger social system, and through risk to members' reputations. Responsibility of a kind is assumed.

These modifications pertain only to mechanics of the management function, not to any of the tasks of management.

Conclusion

In the Rural Development program policy makers have clearly separated the agricultural "poverty" problem from the problem of price for commercial agriculture and have provided an ambitious if modestly financed administrative framework to do something about it. The program at present is largely an action program, but it is in dire need of the analysis of the social scientist, both in process and substance. This paper is an attempt to conceptualize the task facing the land-grant college social scientist. It focuses first of all on the *volitional* action of people as a force in *inducing* economic development, of which the Rural Development effort is a special case, and places the volitional force in context with other forces. Next it views the task of creating a decision-making entity and maintaining communications with it by the federal government. This includes the changing role of the land-grant college in working with the decision maker as an instrument of society in implementing the program. And finally, it conceptualizes the processes of collective decision making through which volitional forces will be activated.

GRAIN STORAGE RULES

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GRAIN storage rules are the central problem in quantitative analyses of grain storage. Levels of year-end grain storage stocks which affect the fluctuation in grain consumption between years have received considerable attention. The implementation of a policy for higher or lower levels of storage must involve a storage program which stipulates the level of storage stocks under any set of given conditions. Such a program can be summarized in a storage rule. The determination of storage rules implied by various grain storage policies and recommendations is the first step in making quantitative comparisons of the amounts stored as well as of costs and benefits.[3]

A storage rule is a statistical decision function such that when the values of the relevant economic variables are known, the level of storage stocks is determined. It usually involves a constant which the total quantity available must exceed before storage begins and a schedule that relates quantity to be stored to the total quantity available when this constant is exceeded. The decision dividing the total quantity of grain between consumption and storage is assumed to be made as soon as the new harvest is in and the total quantity of grain available is known. In any real situation this decision will be modified in the course of the year as information as to the size of next year's crop and changing demand conditions become known.

Two general types of models are used in economic analysis of grain storage. One is essentially a two-year time horizon model. This is best typified by a model that assumes that all storage is managed by private speculators. To derive the storage rule for this model we assume a known demand and some type of rational expectations in regard to the size of next year's crop. The best estimate of this is usually taken to be an average crop. Some two-year time horizon models, however, take into account additional in-

[1] Assistance and counsel in the course of my work in grain storage were given by T. C. Koopmans, H. G. Lewis, D. Gale Johnson and George Tolley. Chris Winston and J. B. Daniels were very helpful. Guidance and help were also provided by G. K. Brinegar, Harold Halcrow and Stewart Johnson.

[2] Scientific Paper 1897, Washington Agricultural Experiment Station. Work was conducted under Project 1307.

[3] For two alternative approaches to this problem see R. L. Gustafson, *Carry-Over Levels for Grain*, U. S. Dept. Agr. Tech. Bul. 1178, 1958; and Conrad Gislason, "The Storage of Grain With Special Reference to International Trade" (unpub. Ph.D. thesis, Univ. of Chicago, 1958). Both derive originally from a co-operative research project between the U. S. Department of Agriculture and the University of Chicago which was initiated in 1951.

The present paper is an introductory delineation of the problem, encompassing for the most part areas in which the author has chiefly worked, but indicating at relevant points the relationship to the work of Gustafson and others.

formation about the probability distribution of crop sizes. Revenue is gained (or lost) in this type of model by taking advantage of the change in value of the stocks held from one time period to the next. A variation we will explore also includes the change in the value of the crops themselves, as affected by storage, in the returns function.

The other general model used in grain storage involves an unlimited time horizon. This model differs from the first in requiring both a complete specification of the probability distribution of crop sizes and a specification of the probability distribution of storage stocks. The stochastic nature of storage stocks can be ignored only in a two-year time horizon. The need to know the probability distribution of storage stocks greatly complicates the grain storage problem. The effect of storage upon the total revenue from a series of crops can be used as a measure of returns to storage in an unlimited time horizon model.

The inherent problems in this model can to some extent be circumvented by assuming that whenever storage decisions are to be made the quantity of grain available is known with certainty. It may, in fact, be true in the real world that whenever storage decisions are made the quantity available is known. However, in selecting a best storage rule where "best" denotes some optimal requirement, the effect of the probability distribution of storage stocks on the conditions involved in the optimum may need to be known.

The basic ingredients of the representations of the two models discussed here are quite simplified. Demand is assumed to be known; a straight line demand curve is used most frequently for illustrative purposes.[4] The distribution of crop sizes is assumed to be known, and to be unaffected by the storage policy. All the grain produced is assumed to be consumed either immediately or after storing. The physical costs of storage are assumed to be of such a nature that the marginal costs are equal to average costs and are not affected by the level of storage undertaken. Except for very high or very low levels of storage this tends to hold true in the American economy.[5]

In this paper a private speculators' storage rule is first developed using the two-year time horizon model. This storage rule represents theoretically the actions in the aggregate of private speculators' storing for gain in a free economy. Since this storage rule has implications for empirical use, a storage rule is estimated for wheat from empirical data. A second theoretical storage rule is developed, on the basis of a two-year time horizon, which maximizes the benefits to farmers when storage is conducted on the basis of taking ad-

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[4] The choice of linear demand curves is made because nonlinear demand curves yield less manageable and, hence, less useful results.

[5] See W. C. Dachtler and E. M. MacDonald: *Costs of Storing Reserve Stocks of Corn*, Marketing Res. Rept. 93, U. S. Dept. Agr., June 1955; and *Costs of Storing Reserve Stocks of Wheat*, Marketing Res. Rept. 124, U. S. Dept. Agr., June 1956.

vantage of a change in price. These models employ the use of a demand curve and an anticipated crop size for next year.

The unlimited time horizon model is introduced by discussing the mathematical problems inherent in predicting the effect of a storage rule on storage stocks and consumption for some years into the future. This problem is then illustrated by the use of a hypothetical probability distribution of crop sizes and a storage rule. The storage rule chosen is similar to the storage rules developed in the previous models. Finally a returns-from-storage function is developed for the unlimited time horizon model.

The Speculators' Storage Rule

A storage rule which approximates the aggregate behavior of private speculators storing for profit is first developed. Grain is stored on the basis of storers' anticipations regarding some variables whose values will not be known when the storage decisions are made. It is assumed that grain storage is carried on by a large number of entrepreneurs, each operating under perfect competition. The net returns or profits from storage for the economy as a whole are therefore zero. (The costs include normal entrepreneurial returns sufficient to hold the number of enterprisers for the industry constant.) The storage rule derived under these assumptions reflects the decision-making process of storers as a group. It does not indicate the action any one of the group would be expected to make except to the extent that this is implied in the actions of the group as a whole.

The average net return to speculators is the quantity stored multiplied by the difference between the price at which they buy and the price at which they sell, less the storage cost per bushel. It can be written as:

$$NR = S[p_1 - p_0 - c] \tag{1}$$

where S is the total number of bushels of grain carried over from one time period to the next, p_0 is the price at which the grain was bought and p_1 is the price at which the grain is sold (the subscripts refer to time periods), and c is the cost of storing a bushel from one time period to the next.[6]

Setting the net returns for storers as a whole equal to zero gives the equilibrium condition for the economy as a whole:

$$p_1 - p_0 = c \tag{2}$$

Although the individual storer does not affect the price of grain by his actions, the quantity stored in the economy as a whole affects the price. Let X_0 be the quantity of grain available during time period 0, q_0 the quan-

[6] The cost of storage includes interest charges for acquiring and holding the stocks from one year to the next. Interest charges generally are known when storage decisions are made. No purpose would be served by introducing the interest explicitly at this point, but it should be borne in mind that this element of cost of storing a bushel of grain is proportional to the price at which the stocks are accumulated.

tity consumed in this time period, and S_0 the quantity carried out of year 0 into year 1. Then we have:

$$q_0 = X_0 - S_0$$

Let the demand curve be written with price as the dependent variable; we have then:

$$p = a - bq \tag{3}$$

and

$$p_0 = a - b(X_0 - S_0) \tag{4}$$

Let $\hat{H}_1$ be the expected harvest at the beginning of time period one, then $\hat{H}_1 + S_0$ is the quantity of grain expected to be available in year one. If all this grain is consumed, then:

$$\hat{p}_1 = a - b(\hat{H}_1 + S_0) \tag{5}$$

Substituting in equation (2), letting $\hat{p}_1$ be the expected value of p_1, and solving for S_0 gives the storage rule:

$$S_0 = \tfrac{1}{2}(X_0 - \hat{H}_1) - \frac{c}{2b} \qquad \text{if } X_0 > \hat{H}_1 + \frac{c}{b}$$

$$S_0 = 0 \qquad \text{otherwise.}$$

More generally we may substitute the quantities $(H_t + S_{t-1} - S_t)$ and $(H_{t+1} + S_t - S_{t+1})$ in equation (3) to determine p_t and p_{t+1} and then apply equation (2) to obtain the relationship:

$$S_t = \tfrac{1}{2}[(H_t + S_{t-1}) - (H_{t+1} - S_{t+1})] - \frac{c}{2b} \tag{6}$$

This is not a storage rule since it does not indicate when storers as a group will accumulate stocks nor does it indicate how much will be stored. Such decisions are made before any information about H_{t+1} and S_{t+1} is available. Hence, these are anticipated values. However, it does not make sense to accumulate stocks this year if next year's anticipated price is too low to give an expectation of profit from selling then. Rather one would hold off buying until next year, or until anticipated profits exist. Hence in storing to take advantage of an expected change in price, grain will be accumulated only in those years when next year's anticipated price is so much higher than the present price that all storage stocks will be sold for a profit. In other words, speculators will adjust their carry-over holdings to such a level that anticipated next year's carry-out is zero.[7] Thus for $(H_{t+1} - S_{t+1})$ in equation (6) we can substitute $\hat{H}_{t+1}$ where this symbol represents the anticipated next

[7] Only when supplies are very heavy and the price is very low does it become feasible to anticipate the holding of stocks for more than one year. These conditions have not occurred very often in the American market. See Conrad Gislason, "The Storage of Grain With Special Reference to International Trade," *op. cit.*

year's harvest. Furthermore, assuming that the grain is of similar quality, speculators are not concerned whether it comes from the current crop or from a previous carry-over. Hence we can also substitute X_t for (H_t+S_{t-1}), giving:

$$(7) \quad \begin{aligned} S_t &= \tfrac{1}{2}(X_t - \hat{H}_{t+1}) - \frac{c}{2b} && \text{if } X_t > \hat{H}_{t+1} + \frac{c}{b} \\ S_t &= 0 && \text{otherwise.} \end{aligned}$$

This is the most general type of storage rule of speculators in a free economy.

It should be noted that in a model in which grain is stored for an anticipated change in price, the anticipated future price is the basic guide to action. However, the correctness of price anticipations depends upon the probability distribution of crop sizes. In other words, although storers act as if next year's carry-over will be zero they will be wrong part of the time. Part of the time, next year's crop will be larger than speculators anticipated and they will again see an opportunity of accumulating carry-over stocks for profit. Part of the time, on the other hand, next year's crop will be smaller than anticipated, prices will be higher, and they will not accumulate stocks anew.

A Farmers' Benefit Storage Rule

Let us now see if we can identify any benefits to farmers from storage by speculators. If the quantity S_0 is stored out of the supply for year 0, the price will be:

$$p_0 = a - b(X_0 - S_0)$$

which is higher by the amount bS_0 than if no storage had taken place. If H_0 is the harvest in this year, farmers' returns are increased by bS_0H_0. In the ensuing year, with harvest H_1, (and assuming no carry-out), price will be:

$$p_1 = a - b(H_1 + S_0)$$

which is lower by the amount bS_0 than if there had been no carry-in. Thus in that year farmers' returns are reduced by bS_0H_1. Hence the combined benefit to farmers over the two years is:

$$TB = bS_0(H_0 - H_1)$$

For benefits actually to accrue, the year in which stocks are accumulated should be a year of a large harvest and supplies with a small harvest in the following year.

This result can be shown graphically (Figure 1). It is assumed that H_0 is a large crop and H_1 is a small crop, and p_0' and p_1' indicate the prices that would have existed if there had been no storage. Under the assumption of linear demand the price enhancement at H_0 resulting from holding out

stocks S_0 is necessarily the same as the reduction in price resulting from adding these stocks to the supply in the next year. For that reason $p_0 - p_0' = p_1' - p_1 = bS_0$, and the total benefit to farmers from storage is, again, $bS_0(H_0 - H_1)$.

It is in the farmers' interests that these benefits be maximized by a storage program. However, the costs of the storage program must be charged against the benefits derived. Let us evolve a storage rule which will maximize the net benefits to farmers. The costs of storage would be the costs of acquiring the stocks plus the costs of holding the stocks less the returns obtained when the stocks are sold. The net benefit function becomes:

$$
\begin{aligned}
NB &= bS_0(H_0 - H_1) - S_0p_0 + S_0p_1 - cS_0 \\
&= 2bS_0(H_0 - H_1) - 2bS_0^2 - cS_0
\end{aligned}
$$

upon making the appropriate substitutions for the prices from equation (3). To maximize the net benefits we set the first derivative of the expression with respect to S_0 equal to zero:

$$\frac{dNB}{dS_0} = 2b(H_0 - H_1) - 4bS_0 - c = 0$$

Solving this for S_0, we have a storage rule:

$$
\begin{aligned}
S_0 &= \tfrac{1}{2}(H_0 - \hat{H}_1) - \frac{c}{4b} \qquad && \text{if } S_0 > 0 \\
S_0 &= 0 && \text{otherwise.}
\end{aligned}
$$

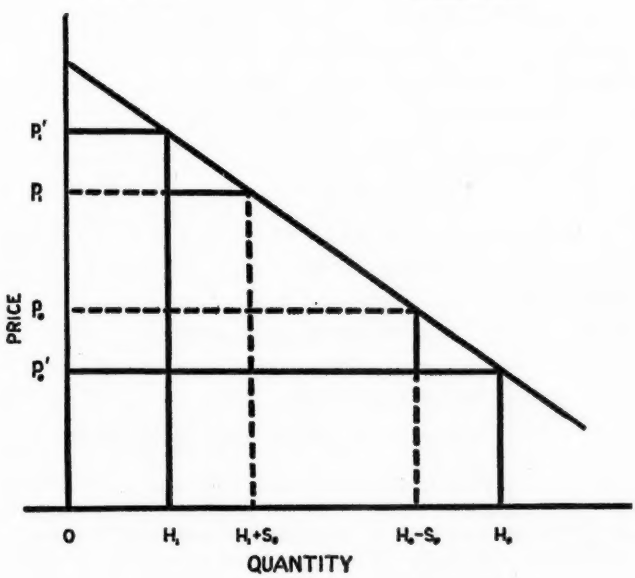

FIGURE 1.

(Since at the time storage decisions are made only the quantity available in the current year (i.e., year zero above) is known, the quantity put into storage must depend on the anticipated harvest in the next year, $\hat{H}_1$.)

We have assumed up to this point that grain was carried out of the harvest only. Let us now see what happens when grain is held out of two successive crops. This will give us a more general storage rule. The receipts of farmers are listed below:

year zero:

$$p_0H_0 = (a - b(H_0 - S_0))H_0 = aH_0 - bH_0^2 + bS_0H_0$$

year one:

$$p_1H_1 = (a - b(H_1 + S_0 - S_1))H_1 = aH_1 - bH_1^2 - bS_0H_1 + bS_1H_1$$

year two:

$$p_2H_2 = (a - b(H_2 + S_1))H_2 = aH_2 - bH_2^2 - bS_1H_2$$

The storage effect for the three years will give the benefits to farmers of the storage program. Choosing the terms involving the S's gives us:

year 0:	bS_0H_0
year 1:	$-bS_0H_1 + bS_1H_1$
year 2:	$-bS_1H_2$
Total benefits:	$bS_0(H_0 - H_1) + bS_1(H_1 - H_2)$

Thus, the form of the benefits is not changed. The benefits are the change in price brought about by the accumulation of stocks multiplied by the change in the size of the harvest between the two successive harvests between which the carry-over was held.

The costs involved wlth the carry-over are altered, however. For the first carry-over (S_0) the total costs involved are:

$$\begin{aligned} TcS_0 &= S_0p_0 - S_0p_1 + cS_0 \\ &= bS_0(H_1 - H_0) + 2bS_0^2 - bS_0S_1 + cS_0 \end{aligned}$$

An additional term, bS_0S_1, is involved arising out of the effect upon p_1, the price in year one, from withholding of stocks S_1 in that year. This term is not an anticipated nor a known cost when the stocks are accumulated, hence, it is not involved in the storage decisions.[8]

For the second carry-over (S_1) the costs are:

$$\begin{aligned} TcS_1 &= S_1p_1 - S_1p_2 + cS_1 \\ &= bS_1(H_2 - H_1) + 2bS_1^2 - bS_0S_1 + cS_1 \end{aligned}$$

[8] When grain is stored there is always some probability that next year's crop will be so large that the quantity stored cannot be disposed of for a profit. On the other hand, there is also some probability that next year's crop will be very small and that considerable profits may be made on the grain held in storage. Neither of these situations can be fully anticipated, but presumably over a large number of years these situations tend to counterbalance each other.

Again the term bS_0S_1 turns up, but in this case it is a known expense when the stocks S_1 are accumulated. Hence, this term becomes involved in the storage rule when the size of S_1 stocks are being determined.

The storage rule for the accumulation of stocks out of the harvest plus previous carry-over can now be determined. For the net benefits equation for S_1 in the listing above, we have:

$$\begin{aligned} NB &= bS_1(H_1 - H_2) - S_1p_1 + S_1p_2 - cS_1 \\ &= 2bS_1(H_1 - H_2) - 2bS_1^2 + bS_0S_1 - cS_1 \end{aligned}$$

Setting the first derivative of net benefits with respect to S_1 equal to zero, we have:

$$\frac{dNB}{dS_1} = 2b(H_1 - H_2) - 4bS_1 + bS_0 - c = 0$$

Solving for S_1, substituting $(X_1 - S_0)$ for H_1 and changing subscripts, we obtain the general rule for storage from the supply in year t, taking account of carry-in from year $(t-1)$:

$$\begin{aligned} S_t &= \frac{1}{2}\left[X_t - \left(\hat{H}_{t+1} + \frac{c}{2b} + \frac{S_{t-1}}{2}\right)\right] && \text{if } S_t > 0 \\ S_t &= 0 && \text{otherwise.} \end{aligned}$$

(We have again substituted an anticipated crop, $\hat{H}_{t+1}$ for the future crop.)

We have derived a storage rule similar in form to the speculators' storage rule. The difference between the two rules is in the amount which the quantity available must exceed before storage begins. For the speculators' storage rule, the amount is a constant, namely, $\hat{H}+c/b$. For the farmers' benefit storage rule, storing begins when the quantity available exceeds

$$\hat{H} + \frac{c}{2b} + \frac{S_{t-1}}{2} \cdot$$

It is not obvious which of the storage rules begins to store at lower levels over a given series of grain crops. This depends on the comparative magnitudes of

$$\frac{c}{b} \quad \text{and} \quad \left(\frac{c}{2b} + \frac{S_{t-1}}{2}\right), \qquad \text{or of } \frac{c}{b} \quad \text{and} \quad S_{t-1},$$

for the crop series. Comparing these two magnitudes brings us up against one of the main problems in dealing with storage rules. We will discuss this topic after we have developed the speculators' storage rule further.

An Estimated Storage Rule

The private speculators' storage rule has reference to the actual world. To test this rule it is necessary to compare it with actual storage under free conditions.

The anticipations of next year's harvest

To test the speculators' storage rule empirically, it is necessary to replace $\hat{H}$, the speculators' anticipations of next year's harvest, by a concrete variable which contains empirical relevance. Since the rate of utilization throughout the year and storage stocks are related, speculators must decide soon after the new crop is harvested the size of the carry-over which will be on hand at the end of the crop year. At this time they know the total quantity of grain available but they have no knowledge of next year's crop, which may not be fully planted until next spring. The crop yield is itself a probabilistic variable. It would seem that under these conditions the best estimate of next year's crop would be an average crop. For an empirical test let us assume that the anticipated price which speculators use as a basis for action is the mathematical expectation of the probability distribution of prices before any carry-in takes place. This permits us to substitute $\overline{H}$ for $\hat{H}$ in the storage rule.[9]

The results of the estimations

The following regression equation was fitted to empirical data on world wheat for the years 1910 to 1929, inclusive:

$$S = a_0 + a_1X_1 + a_2X_2$$

where X_1 is the total quantity of grain available from which carry-over stocks could be accumulated and X_2 is the harvest with which S, the carry-over stocks, must compete in sales. Year-end stocks as of August 1 were used.

The dependent variable was interchanged to account for least square bias. The estimated equations, in millions of bushels, were:

Dependent Variable	*Regression*			*R*
S	$S=-164.28$	$+.3596X_1$	$-.1696X_2$	.9181
		.03715	.04290	
X_1	$S=-255.16$	$+.4300X_1$	$-.2162X_2$	.9476
	.10289	—	.03671	
X_2	$S=\ \ 11.97$	$+.4583X_1$	$-.3434X_2$	.8272
	.24709	.04359	—	

(The standard error of the partial regression coefficient is given below the partial regression coefficient.) The second and third equations have been transposed to show stocks as the dependent variable. (In these cases the standard error of the partial regression coefficient has been divided through

[9] If there is a trend in crop yields, speculators will take this into account. In addition, if there is a trend in demand which shifts the demand curve but does not change its slope, this can also be taken account of in the storage rule.

by the estimated partial regression coefficient of the dependent variable in order to preserve the t-values.) The estimated year-end storage rules were:

Dependent Variable	*Storage Rule*
S	$S=.3596\ (X_1-1{,}673.67)$
X_1	$S=.4300\ (X_1-1{,}890.58)$
X_2	$S=.4583\ (X_1-1{,}959.18)$

These were derived from the estimated regressions by holding X_2 at its mean.

Estimates of year-end stocks will contain working stocks as well as carry-over stocks. Not all working stocks will be used up when the new crop is harvested. Some time is needed to move the new crop into position for use. The time in which grain from the new crop can be made available may vary from year to year, depending on weather conditions. A problem arises in separating working stocks from carry-over stocks if carry-over stock estimates are to be used for statistical analysis.

The mean of the data of the world crops used in the regression is approximately 2,580 million bushels of wheat. Working stocks on August 1 are large; the two smallest in the period studied were 298 and 377 million bushels. The adjustment for working stocks would bring the constant term much closer to the mean of crop sizes for the period. Also using the theoretical slope (.5) in the estimated storage rule brings the constant term closer to the average crop.[10]

Aside from least squares bias, there is a downward bias in the estimates of both parameters of the storage rule which we have not been able to remove. Figure 2 compares a regression fitted to data on year-end stocks generated by an actual storage rule consistent with the theoretical speculators' storage rule. This figure illustrates the discontinuity of such a storage rule which would bias a rule derived from empirical data. The estimated storage rule using unadjusted year-end stocks results in biased estimates of both the constant term and the slope of the storage rule. It would be helpful if we could identify the working stocks and subtract them out of the total

[10] To obtain the constant term in the estimated storage rule we change $S=a_0+a_1X_1+a_2X_2$ into $S=b(X_1-K)$. We have $b=a_1$ and

$$-bK = a_0 + a_2\bar{X}_2 = \bar{S} - b\bar{X}_1$$

or

$$K = \bar{X}_1 - \frac{\bar{S}}{b}$$

From the data we have $\bar{X}_1=3{,}000$ and $\bar{S}=482$ in millions of bushels. This gives (requiring $b=0.5$):

$$K = 3{,}000 - \frac{482}{.5} = 3{,}000 - 964 = 2{,}036.$$

year-end stocks.[11] Whenever year-end stocks were composed only of working stocks these observations should be dropped from the analysis. To get unbiased estimates only the part BC in Figure 2 should be estimated. If observations along AB are included, the results will be biased.

Within-year adjustment of the carry-over

After the crop has been planted and weather and moisture conditions become known, adjustment in carry-over stocks can take place. As the crop year advances, knowledge of the new crop increases and the anticipated

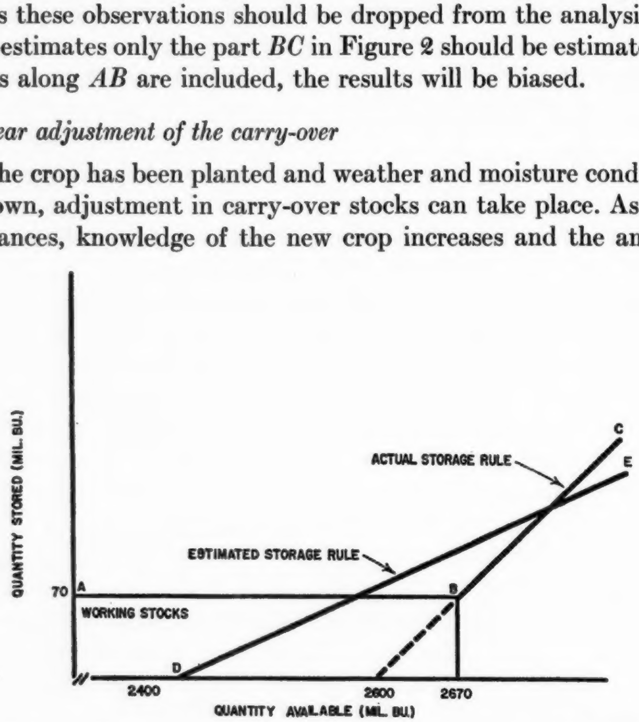

FIGURE 2. ESTIMATED STORAGE RULE WHERE THE AVERAGE HARVEST, $\overline{H}$, IS TAKEN AS 2,400,000,000 BU., c/b AS 200,000,000 BU. AND WORKING STOCKS AS 70,000,000 BU.

crop size becomes more certain. If H_1 is now substituted for $\hat{H}$ in the storage rule, we can see how speculators behave when the size of the new crop becomes more certain. The storage rule becomes:

$$S = \alpha\left[X_0 - H_1 - \frac{c}{b}\right] \qquad \text{if } X_0 > H_1 + \frac{c}{b}$$

$$S = 0 \qquad \text{otherwise}$$

where H_1 is the new crop and X_0 is the total quantity of still-available grain blown up to an annual rate of utilization which, if it exceeds the variable

[11] An iterative procedure was used for the corn crop in the United States. The years in which the estimated storage rule predicted negative storage stocks were eliminated. New rules were estimated until a storage rule predicted positive stocks for all years included in the estimating process. See Conrad Gislason, "The Storage of Grains With Special Reference to International Trade," *op. cit.* This process would remove some of the bias from the slope of the storage rule. An improved estimate of the slope would improve the estimate of the constant term, but unless an estimate of working stocks was made, the constant term estimate would be biased. The period of 1926 to 1938, inclusive, was used. The number of animal units and the change in the price level had significant effects on the amount stored.

H_1+c/b, causes storage stocks to rise by a percentage, a, of the difference between X_0 and H_1+c/b. When the prediction of the new crop has been narrowed down to a small range, a large part of the year has run its course. Hence, the possibility of adjustment to a known H_1 is limited. The slope of .5 in the original rule (equation 7) refers to a period of a full year. This coefficient must be reduced by the fraction of the year remaining (assuming a uniform rate of consumption throughout the year) to determine the percentage a that is applicable after fairly accurate estimates of H_1 can be made.

To indicate the process of adjustment within the crop year, we have the rules:

Dependent Variable	*Storage Rule*
S	$S=.1696\ (5{,}391.24-X_2)$
X_1	$S=.2163\ (4{,}785.84-X_2)$
X_2	$S=.3434\ (3{,}968.69-X_2)$

These empirical rules for adjustment were obtained by holding X_1 at its mean in the estimated regression. The constant in the equations in terms of the estimated variables of the regression is $(1/a_2)\ (\overline{S}+a_2\overline{X}_2)$, where a_2 is an estimate of a. This very simple model is very effective in explaining the storage that takes place in a free economy. The speculators for this period were quite effective in adjusting their holdings of storage stocks in line with the new crop when its size became known. The limited time makes it impossible to adjust to the figure of .5 which applies theoretically for a 12-month period of adjustment. Bias is also introduced in this case by discontinuities. A very small crop occurring when stocks are small will make estimates of the parameters for the spring adjustment lower than they would otherwise be.

In the empirical test it would seem that speculators start storing from smaller crops than the theoretical storage rule would predict. Also speculators may store a little less than 50 per cent of the excess of the quantity above the level at which they began to store.

The Mathematical Problem of Storage Rules

If we are to predict the effect of a storage rule on the probability distributions of storage stocks and consumption, we run into a difficult mathematical problem. A mathematical expression which denotes the effect of a storage rule applied to a probability distribution of crop yields or crop sizes on the resulting probability distribution of the quantities stored can be written as:

$$G(S) = \int_{D(H,S)=S} G(S)p(H)$$

This says that the probability distribution of the quantity stored, $G(S)$, depends on itself and on the probability distribution of crop sizes, $p(H)$, as determined by the storage rule (a statistical decision function) $D(H, S) = S$, which involves both crop sizes and storage stocks. The integral sign indicates that a summation process and areas under the probability distribution of storage stocks and harvests are involved. Similarly, the probability distribution for the quantities consumed can be expressed as:

$$Q(C) = \int_{D(H,S)=C} G(S)p(H)$$

The storage rule which determines the quantity stored also determines the quantity consumed.

This is the stationary condition in which the probability distributions of storage and consumption have become stabilized and are independent of time. Before reaching the stationary state, the distribution of storage stocks can be written as:

$$G_t(S) = \int_{D(H,S)=S} G_{t-1}(S)p(H)$$

The distribution of storage stocks is dependent upon the distribution of preceding year storage stocks and the distribution of crop harvests.

One method of attack is to eliminate storage stocks as a probabilistic variable when consumption and storage in the following year is being considered. This is accomplished by narrowing the problem down to a series of consecutive two-year horizons when storage in a number of crop years is being considered. The following equation is utilized:

$$Q_t(C) = \int_{D(H,S)=C} (S_{t-1} + p(H))$$

where S_{t-1}, the storage stocks from the previous year, are assumed to be known with certainty. This is the situation that would exist in the first year in which a storage program was put into operation. This will be shown below when the operation of a storage rule is illustrated. The effect of carrying over the known S_{t-1} stocks upon the situation in year $t-1$ when the total quantity available is assumed known is considered as well as the effect of carrying the known S_{t-1} stocks into year t when only the probability distribution of crop size is known. The two-year horizon repeats this approach for each consecutive year. Since the size of the carry-over depends in part upon the size of crop harvested, the size of the carry-over becomes a probabilistic variable in any period beyond the initial time period. We have:

$$G_1(S) = \int_{D(H,S)=S} (S_0 + p(H))$$

where S_0 is the size of the carry-over into the first year and is known with certainty. But if we assume that whenever storage decisions are to be made the total quantity of grain available for consumption and carry-over is known with certainty, then this approach can be used. In fact, whenever administrators of a storage policy decided to set the level of the carry-over they would know almost with certainty the amount of the carry-in and the size of the current crop. Hence, by limiting the analysis to points in time in which administrators make decisions, the problem can be simplified. This is the method of approach used by Gustafson.[12]

Rosenblatt solved the relationship:

$$G(S) = \int_{D(H,S)=S} G(S)p(H)$$

and also the concomitant relationship involving the distribution of consumption for a storage rule which stored a constant proportion of the total quantity available after the crop was harvested.[13]

This is essentially a linear storage rule which passes through the origin and can be written as:

$$S_t = \alpha(S_{t-1} + H_t) = \alpha(X_t)$$

Since $S_{t-1}+H_t$ will always be positive, storage stocks will never go to zero. This rule can be modified without changing the mathematical nature of the solution by shifting the rule so that it passes through the lowest possible harvest. Thus, the rule can be written as:

$$S_t = \alpha(X_t - \gamma)$$

where γ is the smallest possible harvest.

For more complicated and perhaps more economically important storage rules, direct solutions do not exist. We must, therefore, resort to indirect methods of determining the effect of other types of storage rules. An iterative process can be applied to a probability distribution of harvests to determine the probability distribution of storage stocks and consumption. This requires the application of the rule to a sequence of crop years and noting the outcome as the probability distribution of storage stocks and consumption becomes stabilized. This is illustrated in the following section.

Illustration of a Storage Rule

Let us suppose we have the following probability distribution of harvests:

size of crop (bushels):	1	2	3	4	5
probability of crop:	.1	.2	.4	.2	.1

[12] *Op. cit.*, pp. 41–42. Consumption and, hence, the gains function (total revenue from consumption less storage costs) depends only on one probability distribution, which is the probability distribution of yield or crop sizes. The probability distribution of storage stocks is not used in arriving at the optimum storage rule.

[13] Rosenblatt, Murray, "An Inventory Problem," *Econometrica*, 13:244–47, April 1954.

The mean of this probability distribution of crop sizes is 3. The variance is 1.2. We wish to apply the following storage rule:

$$S = .5(X - 3) \quad \text{if } X > 3$$
$$S = 0 \quad \text{otherwise.}$$

Let us assume that we are beginning with year zero and we are applying the storage rule to a fixed quantity of grain. The carry-over from year zero is therefore known. Let us assume that this carry-over is zero.[14] With this information we can derive the probability distributions of consumption and carry-over from year one. The probability distribution of consumption is:

Consumption (bushels) =	C_1:	1	2	3	$3\frac{1}{2}$	4
Probability	$=p(C_1)$:	.1	.2	.4	.2	.1

This probability distribution has a mean of 2.8 and a variance of .71. The distribution of storage stocks at the end of year one is:

Stocks (bushels) =	S_1:	0	$\frac{1}{2}$	1
Probability	$=p(S_1)$:	.7	.2	.1

The mean here is .2 and the variance is .11.

If consecutive two-year horizons were being employed, then our illustration would end here. But to look more than one year into the future, we must take into account the probability distribution of storage stocks This distribution changes from year to year but over a sufficient number of years approaches a stable state (with the exception noted below).

To be able to compute the probability distribution of storage stocks and consumption for year two, we need to know the probability distribution of the total quantity available at the beginning of that year, namely, $X_2 = S_1 + H_2$. Since the probability distribution of crops is constant from year to year:

$$p(X_2) = p(S_1)p(H)$$

As a result we have:

$X_2=$	1	$1\frac{1}{2}$	2	$2\frac{1}{2}$	3	$3\frac{1}{2}$	4	$4\frac{1}{2}$	5	$5\frac{1}{2}$	6
$p(X_2)=$	.07	.02	.15	.04	.30	.08	.18	.04	.09	.02	.01

The distribution of storage stocks:

S_2:	0	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{4}$	1	$1\frac{1}{4}$	$1\frac{1}{2}$
$p(S_2)$:	.58	.08	.18	.04	.09	.02	.01

The mean is .27 and the variance is .143350.

The distribution of consumption:

C_2:	1	$1\frac{1}{2}$	2	$2\frac{1}{2}$	3	$3\frac{1}{4}$	$3\frac{1}{2}$	$3\frac{3}{4}$	4	$4\frac{1}{4}$	$4\frac{1}{2}$
$p(C_2)$:	.07	.02	.15	.04	.30	.08	.18	.04	.09	.02	.01

The mean is 2.93 with variance .69635.

[14] The distribution of consumption and stocks for any year depend upon the quantity carried in, but the stationary conditions approached over a period of years are not affected by the size of the initial carry-in.

As we continue this process through successive years the probability distribution of storage stocks tends to become continuous, since the number of possible quantities of stocks between two points continually increases and the probability of any one value continually decreases. This also happens to the distribution of consumption, though less rapidly. The number of values that storage and consumption can take continues to increase in terms of geometric progressions. Nevertheless, the parameters of the distribution tend to stabilize except in the case in which all grain in excess of the constant term is stored and the constant term in the storage rule is taken to be less than the mean of the crop distribution. In this case the mean of the distribution of storage stocks increases without limit and the distribution never stabilizes. Where the constant term in the storage rule is greater than the mean harvest, the storage distribution tends to stabilize rather quickly, especially if the proportion stored is relatively small (i.e., .5 or less). When stability is reached, the mean of the distribution of consumption stabilizes at the mean of the crop harvest distribution.

Only the means and variances of the probability distribution of consumption and storage stocks are given above. The higher moments of the distributions also tend to stabilize in much the same manner.

If we are given the demand curve, we can derive the probability distributions of prices and total revenue from the distribution of consumption.

Selecting a Storage Rule

The central problem in grain storage is the selection of a storage rule. Storage rules determine both the cost and returns to storage since they divide the total quantity of grain on hand into stocks for carry-over and supplies for consumption. A storage rule is selected in terms of given objectives of storage. An optimum storage rule is one which best fulfills the given objective so as to maximize the net benefits. The selection of the proper objective is therefore crucial.

Let us pose the problem of obtaining a storage rule which gives the greatest net returns from a series of crops using the effect of storage on the probability distribution of total returns as the returns to storage. On the cost side, we will ignore changes in the value of stocks held. The storage rule need not be linear and the constant term in the storage rule may be allowed to take on any value in relation to the probability distribution of harvests.

This problem can be attacked on essentially two levels, with intermediate situations:

1. Two-year horizon storage rules can be derived. This is the storage rule which assumes that storage decisions are made only when the total quantity available for future use is known. This method, as has been mentioned, eliminates the need of using a probability distribution of storage in determining the distribution of consumption

2. Storage rules can be derived which take into consideration the dis-

tribution of storage stocks. It is assumed that only in the first year is the total quantity of grain available known. The first simplification would be to obtain the best storage rule when stationary conditions have been obtained. If the transition to stationary conditions is considered, the problem becomes more complicated.

Complete answers to the second approach are required if we are to be assured that the most efficient storage rule has been obtained. One of Gustafson's criticisms of Rosenblatt's approach is that Rosenblatt considers only stationary conditions and hence cannot obtain an optimal storage rule.[15] By the same token, Gustafson cannot be certain of obtaining an optimal storage rule if storage over an extended period is being considered. The only case in which optimality can be obtained by using consecutive two-year horizons to derive a storage rule is when the first-year storage rule and the storage rules under stationary conditions are equivalent. This can only occur if the distribution of storage stocks has no effect upon the optimum storage rule.

A Return Function for an Unlimited Time Horizon Model

If we use the probability distribution of total revenue as the basic guide to storage, we are using a quadratic returns (or weight) function. Hence, if a linear cost function is used (as in the models from which we derived the two storage rules), the storage rule is very likely to be nonlinear.

To see just what it is we are trying to accomplish on the returns side, let us take the expectation of the probability distribution of total revenue. This expectation can be written as:

$$E(TR) = \int pqf(q)dq$$

where p is the price and q is the quantity consumed and $f(q)$ is the probability distribution of consumption. For a straight line demand curve, $p=a-bq$, this becomes:

$$E(TR) = a\int qf(q)dq - b\int q^2f(q)dq$$
$$= aM - bM^2 - bV$$

where M is the mean of the probability distribution of crop sizes and V is the variance of consumption. Thus, the benefit from storage in this case is proportional to the decrease in the variance of consumption.

For a constant elasticity demand curve of the form $p=aq^{-b}$, the expected total returns are:

$$E(pq) = E(aq^{1-b}) = aE(q^{1-b})$$

[15] *Op. cit.*, page 67. Gustafson discusses stationary conditions but does not define them to include a stable distribution of storage stocks.

Thus, in this case the expected total revenue is proportional to the $(1-b)$th moment about the origin. This expected total revenue can be approximated by:

$$E(pq) = aM^{1-b} + a\frac{(1-b)(-b)}{2}M^{-1-b}V$$

which is obtained substituting $(q-M)+M$ for q and expanding by the binomial theorem where the first moment $(E(q-M))$ is zero and the second moment about the mean $(E(q-M)^2)$ is the variance V. This approximation ignores the third and higher moments about the mean. This expectation gives the interesting result that if $|b|>1$ then an increase in the variance will increase the expected total revenue from a series of crops. These expectations give quantitative measures to aspects of storage much discussed in the literature.[16]

Thus, the returns from storage operations can be defined in terms of moments of the distribution of consumption. Over a number of future years, the two-year horizon approach to the derivation of storage rules does not completely specify the probability distribution of consumption. The distribution of storage stocks must be taken into account if the probability distribution of consumption for a future series of crops is to be specified. Hence, in determining the most efficient storage rule, the more complex relationship must be considered.

The most efficient storage rule can be defined in terms of parameters of the distributions of consumption and storage. It would, therefore, be very convenient if, given the probability distribution of crop harvests and the specifications of the storage rule, we could pass directly and immediately to the probability distributions of consumption and storage. If the effect of infinitesimal changes in storage rules were known, then the task of solving for a storage rule would be relatively simple. Since to obtain the effects of a storage rule on consumption and storage we have only the forward iterative procedure outlined above, more work is needed if a quick analytical method of solving these equations is to be obtained.

In contrast to the above methods of attacking the grain storage problem, a model can be set up to simulate the actual operation of storage rules. Random numbers drawn from the correct form of probability distribution are used as harvest yields. By correcting for the standard deviation and the mean of the yield distribution, it is possible to represent the yield of any

[16] D. Gale Johnson, *Forward Prices for Agriculture* (Chicago: Univ. of Chicago Press 1947), pp. 147–77. F. V. Waugh, *et al.*, "The Controlled Distribution of a Crop Among Independent Markets," *Quar. J. Econ.*, 51:1–41, Nov. 1936. Mordecai Ezekiel, "A Statistical, Examination of the Problem of Handling Annual Surpluses of Nonperishable Farm Products," *J. Farm Econ.*, 11:193–226, April 1929. F. V. Waugh, "Market Prorates and Social Welfare," *J. Farm Econ.*, 20: 402–16, May 1938; "Benefit from Price Instability," *Quar. J Econ.*, 57:602–14, Aug. 1944.

crop. The parameters of the storage rule are altered and the effects of such change noted. In this way it is possible to arrive at an optimum storage rule. This general approach has been called the Monte Carlo method. This method has been used to derive storage rules.[17]

Summary and Conclusions

Models for grain storage can be divided into two general groups on the basis of the length of the time horizon they encompass. If it is assumed that the quantity of grain on hand to be divided into consumption and carry-over is known when the storage rule is applied, then the model is essentially a two-year time horizon model. Such a model may use the full specification of the probability distribution of crop sizes to derive a theoretical or hypothetical storage rule. On the other hand such a model may simply use an anticipated harvest to derive a storage rule. The Private Speculators' Storage Rule derived above is a two-year time horizon storage rule which uses the anticipated harvests in its specification. This storage rule has empirical reference since it gives some insight into how private speculators behave in a free economy.

The second type of general model uses a longer or even an unlimited time horizon. In this model the probability distribution of storage stocks is considered in deriving the storage rule. If the nature of the probability distribution of storage stocks does not affect the nature of the "optimum" storage rule, then taking the probability distribution of storage stocks into consideration is unnecessary. Storage stocks affect the probability distribution of the total quantity available. It is very unlikely therefore that they will not influence an "optimum" storage rule. It is total quantity available that must be split into consumption and carry-over.

Given a storage rule and the probability distribution of crop sizes, the probability distributions of consumption and size of the year-end carry-over can be derived. In predicting the nature of the probability distribution of storage stocks some years into the future, we are faced with the problem that the probability distributions of consumption and storage stocks change from year to year, but they approach stable forms after a number of years. In the area of extended time horizons, a number of difficult mathematical problems exist.

One of the unsettled questions in grain storage is the choice of the ultimate objective of storage. This takes us into the realm of public policy and criteria of resource allocation. This problem has been sidestepped in this paper.

However, before an intelligent discussion of grain storage can be undertaken, we must first know in what manner a free private enterprise model

[17] Conrad Gislason, "The Storage of Grain With Special Reference to International Trade," *op. cit.*

functions. To throw light on this question the theoretical private enterprise model was developed and was used as the basis to estimate a storage rule for wheat in the world economy. As a point of contrast with the free-economy, speculative model for storage, a storage rule which maximizes the benefits to farmers from storage was developed using a two-year time horizon. These two theoretical storage rules differed only in terms of the constant which the total quantity available must exceed before storage begins.

COMPUTATION OF VARIANCE ESTIMATES FOR MARGINAL PHYSICAL PRODUCTS AND MARGINAL RATES OF SUBSTITUTION*

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APPLICATIONS of production function analyses to experimental data are now quite common in agricultural economics research. Production functions, usually estimated by the traditional method of least squares, are used to predict cost-minimizing and profit-maximizing input combinations. These estimates of economic optima can then be used by research and extension workers as a guide for making recommendations to farmers.

In practice, however, the sampling variability inherent in experimental data has hindered widespread application of predicted optima to actual farming situations. To remedy this, investigators often increase the number of controlled variables included in the experiments or place probability estimates on uncontrollable variables that influence the outcome of experiments.[1] Even when this is done, the predictions for any given year are point estimates which possess no intrinsic measure of reliability.

Interval estimates (confidence limits) can be used to overcome this last mentioned difficulty. Confidence limits indicate a range of values within which the expected or average value of an estimate may lie, given some probability level. They are based upon the variance of the prediction. Because methods of deriving variance estimates for total physical products predicted by least squares regression equations are well developed, these variances and accompanying confidence limits are sometimes presented in production function analyses.[2] However, production function analyses do not depend upon total products but upon marginal products, and procedures for estimating the variance of the latter are not readily available to all agricultural economists. It would seem important

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[1] For an example of the latter technique, see J. L. Knetsch, "Moisture Uncertainties and Fertility Response Studies," *J. Farm Econ.*, 41:70-76, Feb., 1959. A more general discussion of the problem is given by R. D. Munson and J. P. Doll, "The Economics of Fertilizer Use in Crop Production," *Advances in Agronomy*, Vol. XI, A. G. Norman (editor), New York: Academic Press, Inc., 1959.

[2] J. P. Doll, E. O. Heady, and J. T. Pesek, *Fertilizer Production Functions for Corn and Oats; Including an Analysis of Irrigated and Residual Response*, Iowa State Agr. and Home Econ. Exp. Sta. Bull. 463, Dec., 1958, pp. 378-394.

to be able to estimate variances for these quantities that, in fact, form the basis of the production function analyses.[3]

The purpose of this article is, therefore, to present procedures which can be used to derive variance estimates for marginal physical products and to illustrate their use in setting confidence limits or carrying out tests of significance. The derivation of variance estimates for marginal rates of substitution, which are ratios of marginal products, will also be illustrated. The empirical example involves crop response to commercial fertilizer, but the method presented is generally applicable to any study involving least squares regression methods.

The Experimental Data

The regression equation or production function to be used is

$$\text{(1)}\quad \hat{Y} = -7.51 + 0.584298N + 0.663812P - 0.001581N^2 - 0.001797P^2 + 0.000811NP$$

where $\hat{Y}$ is the predicted yield of corn measured in bushels per acre, and N and P are the pounds of nitrogen and phosphate (P_2O_5) fertilizer applied per acre.[4] This regression equation gave a good fit, accounting for 86 percent of the treatment sum of squares. The experimental plan was a completely randomized design with each treatment appearing twice.

Variance Estimates for Marginal Physical Products

The equations for the marginal physical products (*MPP*) can be obtained by taking first partial derivatives of the production function. Therefore, the marginal product equations for this example are

$$\text{(2a)}\quad MPP_n = \frac{\partial \hat{Y}}{\partial N} = b_n + 2b_{nn}N + b_{np}P = 0.584 - 0.003N + 0.001P$$

$$\text{(2b)}\quad MPP_p = \frac{\partial \hat{Y}}{\partial P} = b_p + 2b_{pp} + b_{np}N = 0.664 - 0.004P + 0.001N$$

[3] This has also been suggested by other investigators. W. B. Sundquist and L. S. Robertson, Jr., state, "When (1) two or more independent variables in a production function occur in product form or (2) more than one variable is used to measure the effects of a particular plant nutrient, it would be desirable to obtain a reliability measure on the derivative of crop yield with respect to individual plant nutrients. Such derivatives are necessarily utilized in determining marginal nutrient effects and consequently optimal applications of plant nutrients. A satisfactory procedure for computing reliability measures for such derivatives has not yet been developed, but it is a critical need in much analytical production economics work." *An Economic Analysis of Some Controlled Fertilizer Input-Output Experiments in Michigan,* Mich. State Univ. Agr. Exp. Sta. Tech. Bull. 269, 1959, p. 24, footnote 16.

[4] This equation was presented by E. O. Heady, J. T. Pesek, and W. G. Brown, *Crop Response Surfaces and Economic Optima in Fertilizer Use,* Iowa State Agr. Exp. Sta. Bull. 424, 1955, p. 304. Details of the experimental conditions are given in the bulletin.

Estimated parameters are presented to six decimals to enable readers to reproduce the results presented herein. Parameters not needed for this purpose will be rounded.

TABLE 1. MARGINAL PHYSICAL PRODUCTS OF NITROGEN WITH STANDARD ERRORS (IN PARENTHESIS) ESTIMATED FOR THE IOWA EXPERIMENTAL DATA[a]

Pounds of Phosphate per Acre	Pounds of Nitrogen per Acre				
	0	80	160	240	320
0	0.584 (0.041)	0.331 (0.026)	0.078 (0.019)	−0.174 (0.026)	−0.428 (0.041)
160	0.714 (0.038)	0.461 (0.021)	0.208 (0.011)	−0.045 (0.021)	−0.298 (0.038)
320	0.844 (0.041)	0.591 (0.026)	0.338 (0.019)	0.085 (0.026)	−0.168 (0.041)

[a] All yields are bushels of corn per acre. Marginal products are predicted by equation (2a) and the standard errors are the square roots of variances predicted by equation (3b).

The coefficients of the marginal product equations are derived from the coefficients of the regression equations. Estimated variances for the latter can be calculated; therefore, variance estimates of the former can also be calculated. An expression for estimating the variance of the marginal product, a linear function, can then be obtained by applying standard methods from statistical theory.[5] For example, for the Iowa data, the expression for the variance of the marginal physical product of N is

$$(3a)\quad \sigma_{MPP_n}{}^2 = \sigma_{b_n}{}^2 + 4N^2\sigma_{b_{nn}}{}^2 + P^2\sigma_{b_{np}}{}^2 + 4N\sigma_{b_nb_{nn}} + 2P\sigma_{b_nb_{np}} + 4NP\sigma_{b_{nn}b_{np}}$$

The estimated variance, found by substituting sample values into (3a), is

$$(3b)\quad \hat{\sigma}_{MPP_n}{}^2 = 0.002 + 0.00000005N^2 + 0.00000001P^2 - 0.00002N - 0.000003P - 0.0000000008NP$$

Because of the symmetry of the treatment combinations used in the Iowa experiment, the equation estimating the variance of the MPP_p is similar to that given for MPP_n. That is, the coefficients are the same, but the occurrence of the N and P symbols are reversed. This would not necessarily be true under different circumstances.

Estimates of standard errors for predicted marginal products of N are given in Table 1. They are quite small relative to the size of the marginal products. The estimated standard error is smallest at the means of the in-

[5] Methods for calculating variances for coefficients of regression equations are given by B. Ostle, *Statistics in Research*, Ames: Iowa State Univ. Press, 1954, pp. 214-217. General methods from statistical theory used in this paper can be found in R. L. Anderson and T. A. Bancroft, *Statistical Theory in Research*, New York: McGraw-Hill Book Co., Inc., 1952.

For readers specifically interested in the method of deriving the variance estimates, a more complete explanation is presented in the Appendix.

TABLE 2. 95 PERCENT CONFIDENCE LIMITS FOR MARGINAL PHYSICAL PRODUCTS OF NITROGEN PREDICTED FOR THE IOWA EXPERIMENTAL DATA WITH PHOSPHATE AT 160 POUNDS PER ACRE[a]

Pounds of Nitrogen per Acre	MPP_n	Lower Limit	Upper Limit
0	0.71	0.63	0.79
80	0.46	0.42	0.50
160	0.21	0.19	0.23
240	−0.05	−0.09	−0.01
320	−0.30	−0.38	−0.22

[a] All yields are bushels of corn per acre.

puts, $N = P = 160$, and increases as the input levels depart from the means. This is characteristic of the method of least squares, which minimizes the variance at the mean. That is, the variation in the magnitude of the estimated standard errors in Table 1 is due to the method of estimation used, the model selected, and the fertilizer levels chosen. For the true rather than the estimated relationship, there is no reason to suppose that the variance of the marginal product occurring at 160 pounds of N and P is smaller than the variance at lesser rates of application. In fact, for biological data of this type, a reasonable assumption might be that yield and variance are positively correlated.

The small size of the standard errors indicates that the predicted marginal products, in this instance, are quite reliable. Thus even when the variance of the predicted yield is large (over 20 bushels for $N = P = 320$), the variance of the slope of the regression equation is not, in a sense, as large.

Table 2 and Figure 1 contain confidence limits for MPP_n, set at the 95 percent probability level. Because P is equal to its mean, 160 pounds, these confidence limits are smaller than would be calculated for any other level of P. If the price of corn were \$1.10 a bushel and the cost of nitrogen were \$0.11 per pound, then the nitrogen-corn price ratio would be 0.10 and the most profitable amount of N would fall between 186 and 204 pounds—a range of 18 pounds. Of course, this range would vary with the price ratio. If the price ratio were 0.60, the optimum could fall within a 40 pound range.[6]

The variance estimates can be used to test the significance of the marginal product. To test whether the average marginal product of N is sig-

[6] The limits given were read from Figure 1. Exact confidence intervals for optimal recommendations can be computed. See Ostle, *op. cit.*, pp. 151-152; and R. L. Anderson, "Some Statistical Problems in the Analysis of Fertilizer Response Data," *Economic and Technical Analysis of Fertilizer Innovations and Resource Use*, E. L. Baum, E. O. Heady, J. T. Pesek, and C. G. Hildreth (editors), Ames: Iowa State College Press, 1957, pp. 203-204.

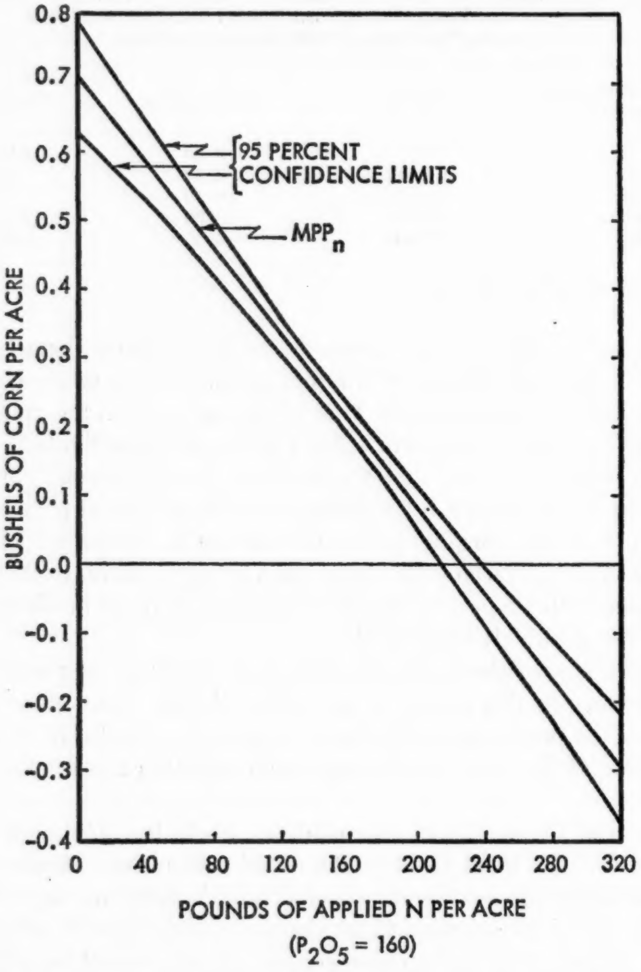

FIGURE 1. 95 PERCENT CONFIDENCE LIMITS FOR THE MARGINAL PHYSICAL PRODUCT OF NITROGEN FOR THE IOWA EXPERIMENTAL DATA.

nificantly different from zero at the points where $N = 160$ and $P = 160$, the appropriate t-test would be

$$t = \frac{MPP_n - 0}{\sigma_{MPP_n}} = \frac{0.21}{.01} = 21$$

where, as given in Table 1,

$$MPP_n = 0.21, \qquad \text{and} \qquad \hat{\sigma}_{MPP_n} = 0.01.$$

This t value is significant at the 0.05 level of probability for 57 degrees of freedom. Significance tests for the marginal product appear useful when

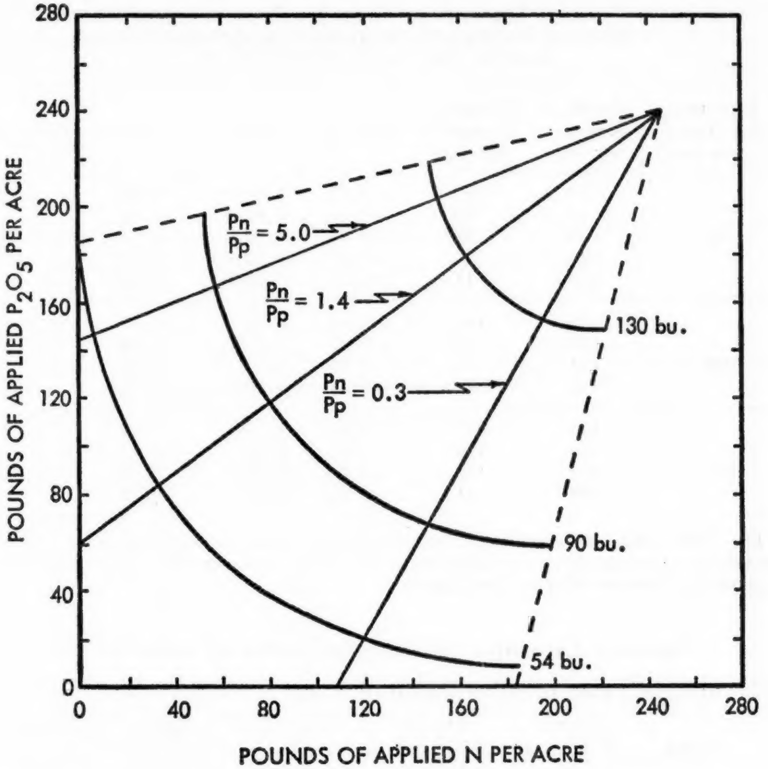

FIGURE 2. CORN YIELD ISOQUANTS AND ISOCLINES FOR THE IOWA EXPERIMENTAL DATA.

"independent" variables in the regression equation are highly correlated.[7] High correlations may indicate that the total effect of an input variable is distributed among several coefficients, especially when interaction or quadratic terms are included in the equation. Further, it can be shown that the quadratic terms such as those in equation (1) also implicitly contain a linear component. For these reasons, individual tests of each coefficient could show some to be significant and others nonsignificant. However, a test of the marginal product equation will indicate the importance of the total marginal effect of the input variable on yield.[8]

[7] Anderson and Bancroft, *op. cit.*, pp. 201-202.

[8] Sundquist and Robertson, *op. cit.*, comment on this as follows, "One might conclude that as individual parameters are not statistically significant, no significant effects are present. This conclusion might well be fallacious. If the aggregate effect of all variables representing a particular plant nutrient could be tested for significance, the test might indicate a significant aggregate effect. This situation illustrates an inadequacy in current statistical testing procedures." The authors believe that the test presented above overcomes this inadequacy.

TABLE 3. VARIANCE ESTIMATES OF MARGINAL RATES OF SUBSTITUTION FOR SELECTED POINTS ON CORN YIELD ISOQUANTS DERIVED FOR THE IOWA EXPERIMENTAL DATA[a]

Expected Yield Level (bu. per acre)	Pounds of Nitrogen per Acre	Pounds of Phosphate per Acre	$MRS_{n,p}$	$\hat{\sigma}_{MRS}^2$	$\hat{\sigma}_{MRS}$	CV (percent)
	10	125	−2.94	0.0889	0.30	10
	40	72	−1.18	0.0081	0.09	8
54	80	38	−0.61	0.0023	0.05	8
	120	20	−0.32	0.0010	0.03	10
	160	11	−0.12	0.0006	0.03	22
	60	161	−3.92	0.2356	0.47	12
	100	96	−0.87	0.0036	0.06	7
90	140	72	−0.39	0.0011	0.03	9
	180	62	−0.11	0.0007	0.03	24
	150	203	−4.91	1.9854	1.41	29
	160	179	−1.49	0.0298	0.17	12
130	180	159	−0.60	0.0050	0.07	12
	200	151	−0.26	0.0032	0.06	22

[a] The *MRS* values were estimated by equation (4). The variance estimates were determined using equations of the general form given in the Appendix; the specific formulae are not given here because of space limitations.

Variance Estimates for Marginal Rates of Substitution

The marginal rate of substitution of N for P for the Iowa data is

$$\text{(4)} \qquad \mathrm{MRS}_{n,p} = \frac{dP}{dN} = -\frac{MPP_n}{MPP_p} = -\frac{0.584 - 0.003N + 0.001P}{0.664 - 0.004P + 0.001N}$$

This *MRS* is a ratio of two linear functions and the variances and covariance of these functions can be estimated. Therefore, as shown in the Appendix, the variance of the ratio (*MRS*) can be estimated.

Several isoquants and isoclines derived from equation (1) are shown in Figure 2. The *MRS* represents the slope of the isoquants and is constant on a given isocline. Table 3 contains estimated variances and standard errors for selected points on the corn yield isoquants of 54, 90, and 130 bushels per acre. Coefficients of variation (*CV*), ratios of the standard

TABLE 4. 95 PERCENT CONFIDENCE LIMITS FOR MARGINAL RATES OF SUBSTITUTION ON THE 90-BUSHEL CORN YIELD ISOQUANT DERIVED FOR THE IOWA EXPERIMENTAL DATA

Pounds of Nitrogen per Acre	Pounds of Phosphate per Acre	$MRS_{n,p}$	Lower Limit	Upper Limit
60	161	−3.92	−2.95	−4.89
100	96	−0.87	−0.75	−0.99
140	72	−0.39	−0.32	−0.46
180	62	−0.11	−0.06	−0.16

errors and the absolute values of the estimated substitution rates, are presented to enable better evaluation of each *MRS* to its standard error.

By examining Table 3 and Figure 2, it can be observed that estimated variances increase in size relative to the absolute value of the *MRS* at the extremes or ends of the isoquants. Again, this effect is a result of the fertilizer levels selected, the method of estimation used, and the model specified.

Table 4 contains the 95 percent confidence intervals for marginal rates of substitution on the 90-bushel isoquant. In least squares analysis, the independent variables are assumed fixed. Therefore, the limits in Table 4 do not represent movements along the isoquant, but rather represent limits within which the slope of the isoquant might fall given each combination of *N* and *P*. For example, when $N = 60$ and $P = 160$, the interval estimate of the slope of the isoquant or *MRS* for this sample is between -2.95 and -4.89. For the same *N* and *P* values, the mean estimate of the slope from this sample is -3.92.

TABLE 5. VARIANCE ESTIMATES OF MARGINAL RATES OF SUBSTITUTION FOR SELECTED POINTS ON ISOCLINES DERIVED FOR THE IOWA EXPERIMENTAL DATA[a]

Isocline Price Ratio $\frac{Pn}{Pp}$	Pounds of Nitrogen per Acre	Pounds of Phosphate per Acre	$\hat{\sigma}_{MRS}^2$	$\hat{\sigma}_{MRS}$	*CV* (percent)
	0	146	0.5638	0.75	15
5	80	176	0.6226	0.79	16
	160	207	2.7441	1.66	33
	0	62	0.0141	0.12	9
1.4	80	120	0.0111	0.11	8
	160	178	0.0272	0.17	12
	120	24	0.0010	0.03	11
0.3	160	93	0.0011	0.03	11
	200	161	0.0045	0.07	22

[a] The variance estimates were derived using an equation of the form presented in the Appendix.

Table 5 contains variance estimates for selected points of three isoclines. The estimated variances increase for points farther out on the isoclines—that is, for points denoting larger inputs of *N* and *P*.

Confidence limits calculated for the isocline labelled 1.4 ($Pn/Pp = .13/.09$) are presented in Table 6. A 95 percent probability level was used. The confidence limits are widest on the extremes of the isocline. For $N = 200$ and $P = 207$, the limits have a range of 1.56. Generally the range is about 0.4.

Table 6. 95 Percent Confidence Limits for Marginal Rates of Substitution for Points Along the Isocline ($Pn/Pp=1.4$) Derived for the Iowa Experimental Data

Pounds of Nitrogen per Acre	Pounds of Phosphate per Acre	$MRS_{n,p}$	Lower Limit	Upper Limit
0	62	−1.44	−1.20	−1.68
80	120	−1.44	−1.23	−1.65
160	178	−1.44	−1.10	−1.78
200	207	−1.44	−0.66	−2.22

The upper confidence limit for most points along the isocline is, when N is less than 200 pounds per acre, about 1.7. In terms of price variations, if the price of P is held constant at \$0.09 per pound (the isocline was derived for prices of \$0.09 and \$0.13 per pound for P and N, respectively, a price ratio of 1.44), an increase in the price of N to \$0.153 per pound would increase the price ratio to 1.7. Or, holding the price of N at \$0.13, a decrease in the price of P to \$0.076 per pound would increase the ratio to 1.7. Price variations needed to attain the lower limit of 1.2 are similarly small. Thus, if the price of either N or P is held constant at \$0.13 or \$0.09, respectively, the range in the *MRS* indicated by the confidence limits in Table 6 can be attained by approximately a \$0.02 change in the nutrient price that is allowed to vary. In terms of nutrient price variations, the confidence limits represent a relatively small range.

Summary

This article has presented procedures that can be used to derive variance estimates for marginal physical products and marginal rates of substitution. These procedures are based on techniques developed in statistical theory but not readily available to many agricultural economists. The derivation of these variances will give the research worker an indication of the sampling variability of the quantities on which he bases his analysis and will enable him to make tests of significance or set confidence limits. This would appear to be a useful addition to many production function analyses.

Estimated variances of marginal products and marginal rates of substitution were comfortingly small for the example presented. And, although the two variances are not strictly comparable, the estimated variances for marginal products appeared small compared to the estimated variances for total products. This suggests that estimates of marginal products, the slopes of yield curves, may be quite reliable even when estimates of total yields, the heights of yield curves, appear to be relatively unreliable. This conclusion is highly tentative but hardly unexpected when a wide range of values is selected for the independent variables. Of course, additional analyses are needed to indicate the size of the variance of marginal product estimates under varying conditions.

Appendix

A linear function

$$L = a_1x_1 + a_2x_2 + \cdots + a_nx_n = \sum_{i=1}^{n} a_ix_i$$

has an expected value

$$E(L) = \sum_{i=1}^{n} a_iE(X_i) = \sum_{i=1}^{n} a_i\mu_i$$

if $E(X_i) = \mu_i$. It has a variance

$$\sigma_L^2 = E[L - E(L)]^2 = \sum_{i=1}^{n} a_i^2\sigma_i^2 + 2\sum_{i<j}\sum a_ia_j\sigma_{ij}$$

Therefore, the estimated variance of MPP_n, a linear function of N and P, is

$$\hat{\sigma}_{MPP_n}{}^2 = \hat{\sigma}_b{}^2 + 4N^2\hat{\sigma}_{b_{nn}}{}^2 + P^2\hat{\sigma}_{b_{np}}{}^2 + 4N\hat{\sigma}_{b_nb_{nn}} + 2P\hat{\sigma}_{b_nb_{np}} + 4NP\hat{\sigma}_{b_{nn}b_{np}}$$

where

$$MPP_n = b_n + 2b_{nn}N + b_{np}P$$

and

$$b_n = \text{coefficient of } N \text{ term of regression equation}$$
$$b_{nn} = \text{coefficient of } N^2 \text{ term of regression equation}$$
$$b_{np} = \text{coefficient of } NP \text{ term of regression equation}$$

Variances and covariances of the regression coefficients are calculated by the usual method. The estimated variance of MPP_p is found in a similar manner.

The marginal rate of substitution is a ratio of marginal products

$$R = MRS_{n,p} = -\frac{MPP_n}{MPP_p} = -\frac{\mu_T}{\mu_B}$$

where T represents the numerator and B represents the denominator. The variances of the marginal rates of substitution were estimated by[9]

$$V(R) = \frac{\mu_T^2}{\mu_B^2}\left(\frac{\sigma_T^2}{\mu_T^2} + \frac{\sigma_B^2}{\mu_B^2} - \frac{2\sigma_{TB}}{\mu_T\mu_B}\right)$$

The derivation of estimates of σ_T^2 and σ_B^2 was given above. Estimates of μ_T and μ_B are

$$\hat{\mu}_T = MPP_n$$
$$\hat{\mu}_B = MPP_p$$

[9] This expression is based on the approximate formula for the variance of a ratio presented in W. G. Cochran, *Sampling Techniques*, New York: John Wiley and Sons, Inc., 1953, p. 117.

Finally, σ_{TB} is estimated by

$$\hat{\sigma}_{TB} = E(TB) - \hat{\mu}_T\hat{\mu}_B$$

where

$$E(TB) = E[(MPP_n)(MPP_p)]$$

For estimation of σ_{TB}, relationships of the following type must be used

$$E(x_1x_2) = \sigma_{x_1x_2} + \mu_{x_1}\mu_{x_2}$$

$$E(x_1^2) = \sigma_{x_1}^2 + \mu_{x_1}^2$$

Substitution of these estimates into $V(R)$ gives an expression for the variance of the *MRS*. For the illustration presented, $V(R)$ is a function of N, P, the estimates of the parameters in the production function, and the error mean square. For those wishing to reproduce the results presented herein, the error mean square for the Iowa data is 156.07 with 57 degrees of freedom. The elements of the inverse matrix are

$$c_{n,n} = c_{p,p} = 1.0681 \times 10^{-5}$$

$$c_{nn,nn} = c_{pp,pp} = 8.2550 \times 10^{-11}$$

$$c_{np,np} = 6.3472 \times 10^{-11}$$

$$c_{n,p} = 1.9625 \times 10^{-6}$$

$$c_{n,nn} = c_{p,pp} = -2.6217 \times 10^{-8}$$

$$c_{n\,pp} = c_{p,nn} = -1.3966 \times 10^{-9}$$

$$c_{n,np} = c_{p,np} = -9.7573 \times 10^{-9}$$

$$c_{nn,pp} = 4.6741 \times 10^{-13}$$

$$c_{nn,np} = c_{pp,np} = 1.2445 \times 10^{-12}$$

The approximation given above for the variance of a ratio, $V(R)$, appears to be adequate for the example used in this paper. As explained later, this is because of the magnitudes of relevant coefficients of variation and the number of degrees of freedom (57) for the estimate of the error variance in the Iowa experiment. In other cases, the method of Fieller may be superior.[10]

The ratio estimate, or the index as it is called in Fieller's paper, is a difficult problem in the sampling literature in statistics. It seems reasonable to believe that the numerator and denominator of the expression for a marginal rate of substitution might have a bivariate normal distribution. Note that this statement does not say that the MRS is normally distributed. From this bivariate normal assumption, it follows that

$$t = \frac{T - RB}{(\hat{\sigma}_T^2 + R^2\hat{\sigma}_B^2 - 2R\hat{\sigma}_{TB})^{1/2}}$$

[10] E. C. Fieller, "The Distribution of the Index in a Normal Bivariate Population," *Biometrika* 24:428–440, 1932.

T and B denote the numerator and denominator as before, R is the true unknown MRS and t is Student's t. The expression just given does follow the probability distribution of t because $T-RB$ is normally distributed and the denominator contains a proper sample estimate of the standard deviation of this difference. Squaring both sides and solving the resulting quadratic for the unknown R (after specifying the t-value for the desired confidence limits) will yield values of R that may be used to set confidence limits for the MRS.[11] The solution of this quadratic may be expressed as

$$\frac{\frac{T}{B}\left[\{1 - t^2C_{TB}\} \pm t\{(C_T + C_B - 2C_{TB}) - t^2(C_TC_B - C^2{}_{TB})\}^{1/2}\right]}{1 - t^2C_B}$$

where C denotes the square of a coefficient of variation, i.e.,

$$C_T = \frac{\hat{\sigma}_T{}^2}{\hat{\mu}_T{}^2} \quad \text{and} \quad C_{TB} = \frac{\hat{\sigma}_{TB}}{\hat{\mu}_T\hat{\mu}_B}\,.$$

There will be two solutions for the quadratic and it is possible for both solutions to be imaginary. However, Cochran points out that imaginary roots are unlikely to occur when the coefficients of variation for T and B are less than 0.3. This requirement is fulfilled for the example presented in this paper for most of the region of interest (see Table 1). Cochran further states that when the products t^2C in the above solution are small relative to 1 then the confidence limits obtained will be

$$\frac{T}{B} \pm t[\hat{V}(R)]^{1/2}$$

where $\hat{V}(R)$ is the estimate from the sample data of $V(R)$ already given above. This condition is also met by the Iowa data. Each investigator, however, will need to consider his own data in regard to these points.

[11] Cochran, *op. cit.*, p. 121.

A "UNIT SURVEY" CENSUS IN SOUTHERN PERU

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THE Southern sierra of Peru was cultivated for centuries under the Incas and later became a center of the Spanish conquest. Today, however, it comprises an economically depressed area within Peru and has recently become the object of a joint US-Peruvian study program sponsored by the International Cooperation Administration (Point Four). A regional economic analysis program was established in 1957 to furnish a basis for development planning.

The lack of basic statistics, however, became the first problem to demand a solution. The last population census was taken in 1940. There had never been an agricultural census, which was an especially serious problem since the area's economy is essentially agricultural. Available information on the area's agriculture as a whole was limited to little more than estimates of production of a few major crops; clearly an inadequate basis for the necessary studies. The limitations on time and money ruled out the possibility of the standard enumeration census, so that other means of effecting an inventory of agricultural resources had to be sought. It was found that certain characteristics of the area's social and political organization lent themselves to a different type of census which has produced satisfactory data within a short time and at a comparatively low cost.

The area involved is slightly less than the combined areas of New York and Pennsylvania, with a total population of 2.7 million. It includes remarkable contrasts in altitude, crops and social conditions. From 12,000 to 16,000 feet above sea level there are vast windswept areas of tundra-like range suitable for sheep, llamas and alpaca. At this altitude there is some primitive cultivation of potatoes, barley and quinua, which gradually gives way to such crops as corn, tea, coffee, sugar cane, and, at still lower altitudes, to other tropical crops and jungle. The terrain is extremely rough and most of the cropping is confined to narrow valleys that lie among wide areas of high mountains and relatively unproductive range.

Crop and livestock production are conducted under either of two systems; *parcialidades* or *haciendas*. The *parcialidades* are Indian communities, remnants of the old Inca social structure. They vary considerably in point of population and agricultural resources but are quite uniform with respect to the general poverty of the inhabitants, their primitive farming methods and their strong orientation toward subsistence production. The essential characteristic of the *hacienda* is that it maintains families of tenants, or "colonos." These may vary from one to a hundred families. Although they are ostensibly commercial farming units, management

practices are crude in many instances, often approaching those of the aboriginal population. At the other end of the spectrum there are operations that are managed creditably by United States standards.

Communications in this area are difficult and the communities have existed in isolation, which continues even today in many places despite the recent introduction of roads. The evolution of agricultural production and of the *parcialidad-hacienda* system under such conditions led to the development of rural conditions that vary erratically from one area to another. It would have been impossible to obtain definitive data through "sampling"; only a complete census survey could have provided the basic data that were needed. A complete area-by-area survey was especially needed because it was necessary to know the geographical distribution of agricultural resources as well as their total quantity.

The opportunity to make a simple but comprehensive census was found in the social and political organization of the area. The lowest political subdivision, the "district," has an average population of roughly 1,300 families divided typically into seven *parcialidades* and about ten *haciendas* each with a few "colonos." The districts, with some exceptions, are quite small and are well known to the more alert inhabitants, so it seemed that whatever they did not already know could be estimated with reasonable accuracy. The same is even more true of the smaller units, the *parcialidades* and *haciendas* (hereinafter referred to as "units").

It therefore seemed feasible to base a survey entirely on these smaller units and, by systematically interviewing local leaders, to obtain reasonably good estimates regarding salient aspects of economic activity within each individual unit. If the results were recorded uniformly so as to include all farm and livestock production in the entire area, it was evident that through systematic tabulation such details could be built up into district, provincial and departmental totals. Substantial errors seemed unlikely if the component details of the data were confined to empirical estimates of very small units and simple concepts well within the comprehension of local informants. It was also evident that the inquest had to be sharply limited to outstanding and essential aspects of each unit.

There are about 390 districts in the sierra of the study area (the Departments of Apurimac, Ayacucho, Arequipa, Cuzco, Puno, Tacna and Moquegua) and field work required about fourteen months. A number of problems relating to accuracy and supervision had to be considered, as described below, but on balance the results were quite satisfactory.

Procedure

The field work was divided between teams of investigators, who were organized and functioned as indicated:

1. Each team consisted of two graduate agriculturalists and was provided with a vehicle.

2. The older, or senior investigator, was in charge of the vehicle, planning the itinerary and other administrative aspects of the field work.

3. Both were instructed that neither was subordinate with respect to judging and evaluating the data obtained. Rather, both were equally responsible for any deficiencies in the data. If the two could not agree, they were to maintain separate records of the material in question.

4. The teams carried standardized work forms (schedules) to be filled out for each district. These provided a column for each component unit (*parcialidades* and *haciendas*) in which the corresponding populations, crop and livestock data were to be entered.

5. The investigators were given official status. The Lima office officially informed provincial prefectos of the program and asked that district officials be requested to collaborate.

6. The investigators sent messages ahead of them informing district officials of their arrival. This was in the nature of making an appointment.

7. Upon arrival in the district, the teams met with the local district and municipal officials and with as many other local leaders or bystanders as could be discreetly included in the group.

8. All discussion was on a group basis, and was usually initiated by the investigators asking the names of all *parcialidades* and *haciendas* within the district. These were entered at the top of their respective columns on the work forms. Following this, interest shifted to specific units, which were discussed individually and in sequence.

9. Regarding each individual unit the investigators methodically inquired about specific details: ". . . how many families? . . . with land? . . . without? How much corn under irrigation? . . . unirrigated? . . . potatoes?" On *haciendas:* ". . . how many tenants? . . . how many sheep do they have? . . . how many does the owner have? . . . cattle?" . . . and so on.

10. On each point of information time was allowed for discussion among the group and for cross check questions by the investigators. Examples of such questions might be: "Is there really twice as much corn under irrigation as there is in dry fields?" "Is it true then that the tenants on *Haciendas* A and B have about the same total number of sheep?" When the group had reached a consensus on each point, the information was recorded.

11. After completely treating one unit, another was examined in the same way until data were recorded, uniformly and completely, on all agricultural activities in the *parcialidades* and *haciendas* making up the district.

12. The group was encouraged to talk in terms of local measurement

units that were familiar to them: *Topos, fanegadas,* etc. Conversions to metric units were made later.

13. In addition to population, crop and livestock data obtained from individual units as described above, the teams recorded other data, some of which could only be generalized; for example, average yields per hectare on irrigated and unirrigated land in both "normal" and "good" years. (*Haciendas* and small farmers were considered separately.) Even more approximate: an estimate of the quantities of crops and livestock sold in both "normal" and "good" years. Also, information was obtained on such subjects as the distance from the area to medical facilities, the existence of mine sites and the number of small industries.

Concept and Reasons Underlying the Procedure

1. The cultural and geographic isolation of the districts and their component units cause the inhabitants to be intensely aware of and well informed about conditions within their localities. To obtain collaboration and well-considered, unbiased information and to evaluate it uniformly seemed to be the chief problem.

2. The investigators were all trained agriculturalists since knowledge of agriculture was essential in dealing with local groups and in evaluating their information. Only men who were already familiar with sierra agriculture were employed.

3. The investigators travelled in teams of two, largely to compensate for the almost complete lack of day-to-day supervision, which was inevitable because of the large and isolated area to be covered. It was believed that a man working alone could well fall into a routine, gradually lowering his standards of astuteness and perception. But with two men, continual prudence, discussion and mutual stimulation was more probable, and hence valid data seemed better assured. (The physical danger of prolonged travel in rough and isolated country was also considered.)

4. Official status for the investigators and support from the provincial officials was necessary due to the usual reluctance of officials to divulge information without specific instructions from their superiors.

5. Group discussion within the districts was adopted to avoid misrepresentation. This often occurs when the persons interviewed have a special interest in presenting a biased picture. Mistrust of government functionaries is quite common in most underdeveloped countries. It is difficult, however, for a person to deceive when he is surrounded by others with equal knowledge of the truth. The investigators recorded only the consensus of the group and it is unlikely that much deliberate falsification could occur under such circumstances.

6. The motivation for false answers was greatly reduced since the questions were mainly impersonal. (Fear of tax assessments and army recruitment is often a serious obstacle to this type of survey.) Information on the *parcialidades* made no reference to specific persons. That regarding *haciendas* contained some specific reference to the owner, but there is no evidence that it caused any bias.

7. The investigators were coached to deal tactfully with the local groups, to gain their confidence and to observe their reactions. Also, they were instructed to make their own survey of the district in so far as time permitted, to cross check and otherwise test the data given.

8. The inquest was limited to a few simple concrete concepts that were easy to understand and which lent themselves to straightforward estimation or measurement (the area planted to potatoes, for example). In the field these total concepts were considered only in their component details and in small segments easy to grasp—the area of potatoes, irrigated and unirrigated, belonging to small farmers, to tenants, and so on, in specific units. In brief, local groups were asked only what they could be expected to know. Abstract concepts were deliberately avoided since they would have confused both the investigators and the local groups, resulting in unsound or questionable statistics at an increased investment of time and money. Such abstract concepts might have included the distribution of small farms by size, farm income, cost of production, etc. Such matters were left to be developed by a separate sampling project.

9. Three teams were activated, a total of six investigators. This was judged to be sufficient to complete the work within the time available, but still small enough to provide uniformity of judgment and comparability of resulting data.

The Program in Operation

The most essential technical requirement was achieved; in practically all instances the teams had little difficulty in meeting with local groups that were well informed and concerned in helping. Groups typically numbered from seven to ten people, but on occasion as many as thirty-five gathered together. From efforts to furnish exact data, discussion occasionally became heated but it was always sincere. In the more recently established districts at lower altitudes nearer the jungle, the work tended to be more difficult. This may have been due to the less stable nature of the settlements, which were often still in the process of development with fewer and weaker bonds among the inhabitants. Where the investigators arrived in a district during a local fiesta it was hard to arouse interest in the survey. In these few cases, special efforts were made to get the information. The investigators checked the data whenever possible with

outsiders (extension agents, the agricultural development bank). In general, it is safe to conclude that, although some errors of estimation may have occurred, the data were honestly arrived at and basically sound.

The time factor was a major problem. Much of the traveling was on horseback, slow in itself, and sometimes difficult to arrange where horses were scarce. It generally required from two to three hours to locate and assemble the key individuals in each district. The discussion itself usually lasted about three hours and some social amenities before or afterward were difficult to avoid. On the average, a team could treat one district a day where cars could be used. Traveling by horse required roughly two days per district. Additional delays were imposed by such factors as rains, holidays, vehicle breakdowns and injuries, causing the work to exceed somewhat the original time schedule.

No serious obstacles occurred and, except for administrative problems, the program proceeded smoothly, having been adapted to only what could reasonably be expected of both the investigators and the local groups. Tabulation was essentially a simple matter.

Evaluation of the Project

The body of data that emerged constituted a very great increase in the information available on the study area. Much more accurate and detailed estimates were obtained of livestock population, area in individual crops and total cultivated area. The project's more notable contribution, however, was in producing data on the conditions of agricultural production. The study area included over 5.0 million acres of crop land and almost 4.5 million animal units. This was the first effort to determine the total number of farming units (339,000, large and small), as well as their distribution by type of tenure. The distribution of ownership or management of livestock and land as between *hacendados,* tenants and small Indian farmers became known for the first time. The project also determined regional variations in land tenure and the distribution of *haciendas* by size. It also resulted in comprehensive data on the area under irrigation and the use of irrigated land by large and small producers for various crops. For the first time it was possible to measure the population and land resources served by the existing road system as well as the population and resources located at various distances from the road end. Useful estimates were produced on commercial farm production in the different regions and variations in the incidence of improved livestock. Project data indicated the total number of indigenous community centers and produced additional information regarding nonfarming activities such as the number of small industries, commercial establishments and employment in mines.

It will be evident that such information is essential to determining the requirements of economic development, planning further research and deploying a field force to actually implement economic improvements. The data produced by the project, supplemented by other studies sponsored by Point Four, provides a basis for agricultural planning which, with respect to accuracy and scope, has few precedents in Peru.

It is probable that the data is affected by some errors of estimation at the *parcialidad* and *hacienda* level, but it must be supposed that such faulty estimates were mutually compensating to a large extent at the district level. It is also probable that the over-all accuracy is less than that of data produced by censuses in more highly developed countries. Peru has no data gathered with comparable thoroughness, so that relative accuracy cannot be determined. But this project will doubtless be of lasting benefit to Peruvian statistics in that the data provides a point of departure for future data-gathering projects, a "frame" for some future enumeration census.

At the same time, it should not be assumed that the first enumeration census taken in the same area would yield data having much greater accuracy. Within the present Peruvian context, recruiting and training a staff of enumerators would present many opportunities for "slippage." Supervising them in the field would present more. But even more important is the well-known reluctance of the local population to speak frankly when directly queried about its personal affairs. A formal enumeration census therefore would also contain defects; and it is possible that these defects would be about as great as those in the more empirical "unit survey" census described here. It is not contended, however, that the "unit survey" census is a substitute for the other type; rather, enumeration censuses are esssential, but a high degree of accuracy in such countries as Peru can be expected only after the census organization becomes stable and gains experience and public confidence through repeated operations.

The object of the present discussion is to demonstrate that where ordinary census data are lacking the statistical basis for agricultural planning can be obtained within a short period and at a low cost through a "unit survey" census, provided that certain conditions prevail. The area must be divided into social and economic units small enough for alert inhabitants to be familiar with and able to estimate the size of all salient components. The population and type of agricultural activity must be stable. Where such is the case, it is possible for qualified investigators to obtain a mass of detailed empirical estimates that can be compiled to yield reasonably accurate agricultural data. This is of significance to many development programs throughout the world that are handicapped by a lack of basic information.

LAND ACCUMULATION IN THE TURKISH ÇUKUROVA

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The Problem

THROUGHOUT the Middle East one of the more serious and perplexing problems facing local governments has been that of land reform. In nearly every country some effort has been directed toward modifying inequalities resulting from land inheritance customs, tenure conditions, and absentee land ownership.

The land reform program of the Turkish government has been one of the more successful in the area. A land redistribution policy was adopted after the 1923 revolution and serious attempts were made to divide church, state, and private estates among that segment of the agricultural population which was landless. Thus, in theory at least, the bulk of the Turkish villagers were possessors of agricultural land.

In the three and one half decades since the establishment of the Turkish Republic and the early days of land reform, a type of agricultural occupance has developed which few of the reformers envisioned. This is *çiftçi* agriculture in which land accumulation has resulted from prudent management of existing land, labor, and capital rather than by inheritance; in which land owners have continued to play an active role in farm operation and management rather than becoming absentee landlords; and in which capitalism rather than feudalism is the major theme in the rural economy.[1]

This study considers *çiftçi* agriculture in only one section of Turkey—the *Çukurova,* a rich agricultural area along the country's Mediterranean coast. The nature, historical evolution, and extent of *çiftçi* agriculture within the Çukurova are described; several factors which have favored its development are investigated; and its possible future development is considered. Similar developments in other sections of Turkey are not considered, and the generalization cannot necessarily be made that similar conditions are operative throughout the country.

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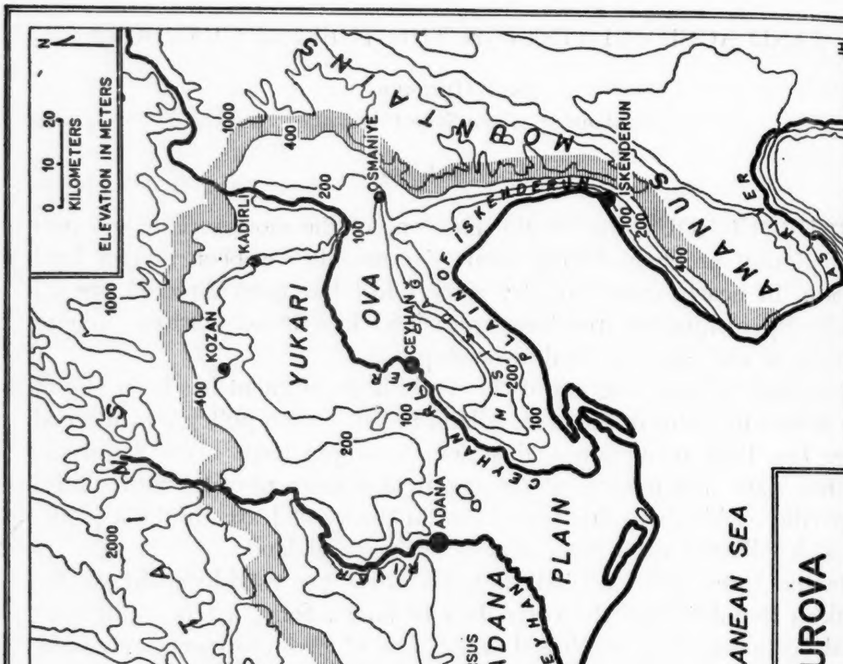
[1] In Turkey the typical agriculturist is called villager (*köylü*) rather than farmer (*çiftçi*). The terms *çiftçi,* and *çiftlik* (farm) are reserved for large, centrally managed land holdings. Since no uniform quantitative definition exists for a *çiftlik,* an arbitrary size definition has been utilized in this paper. This definition states that a *çiftlik* is an operating farm of at least 100 hectares (247 acres).

See: N. Helburn, "Stereotype of Agriculture in Semi-arid Turkey," *Geographical Review,* 45:375 (July 1955).


THE ÇUKUROVA
MEDITERRANEAN SEA
KILOMETERS
0 10 20
ELEVATION IN METERS
N
YUKARI OVA
ADANA PLAIN
MIS PLAIN
PLAIN OF ISKENDERUN
CEYHAN RIVER
SEYHAN
TARSUS RIVER
GÖKSU RIVER
AMANUS MOUNTAINS
ADANA
TARSUS
MERSİN
SİLİFKE
CEYHAN
OSMANİYE
KOZAN
KADIRLI
ISKENDERUN
TURKEY
Istanbul
Ankara
ÇUKUROVA
Halep
JH

The Area

The core of the Çukurova is a lowland area of alluvium which has been deposited by the Seyhan and Ceyhan Rivers, their tributaries, and several small streams which flow directly into the Mediterranean (Figure 1). This lowland area is divided into four semi-isolated sub-lowlands; the Adana Plain, the Yukari Ova, the Plain of Iskenderun, and the Plain of Erdemli.

The Adana Plain, the largest of the lowlands in the core, extends along the Mediterranean Sea from the city of Mersin to just east of the mouth of the Ceyhan River. The area has a table-like surface and its deep, stone free, clayey soils are for the most part fertile. Local relief is slight and villages many miles from the Mediterranean are only a few feet above sea level. Small mounds occasionally rise fifty or sixty feet above the surrounding countryside, but they occupy only a small portion of the Plain's area.

The rivers of the Plain, the Seyhan, the Ceyhan, and the Tarsus (Berdan), meander widely across the level surface on their way to the Mediterranean. Each is bordered by a maze of oxbow lakes, meander scars, and natural levees. Near the Mediterranean, particularly in the vicinity of the rapidly expanding deltas of the Seyhan and Ceyhan, swamps and shifting sand dunes are common. The major urban agglomeration of the Çukurova, Adana, as well as the cities of Mersin and Tarsus, is located in the Plain.

The Yukari Ova, which lies to the northeast of the Adana Plain, is completely surrounded by hill country and is somewhat isolated from the Mediterranean (Figure 1). It has a flat surface, much like that of the Adana Plain. The major river of the Ova, the Ceyhan, flows from east to west across the southern part of the area. The local relief of this area is greater than that of the former, although most sections of the Ova are less than 150 feet above the Mediterranean.

The coastal plains of Iskenderun and Erdemli lie to the south and the west of the other two plains (Figure 1). Both extend along the Mediterranean and are backed by mountain ranges which restrict movement toward the interior of the country. The two Plains, although they are the product of alluvial deposition, are not as level as either the Adana Plain or the Yukari Ova since the rivers of both are short and torrential and have not meandered extensively like the Seyhan and Ceyhan. As a result, soil, drainage, and topographic conditions vary greatly from place to place.

These lowlands are flanked by two areas of dissected hill country (Figure 1). The first is a foothill belt which lies along the base of the Toros and Amanus Mountains. The Amanus foothills in the east are narrow but

the Toros foothills to the northeast, north, and northwest are fairly broad. The second area is the Misis Dag, an isolated group of low hills, which is east of the Adana Plain between the Yukari Ova and the Mediterranean. Much of the land in the hill country is in slopes which have been denuded of both forest and soil cover by years of goat grazing and overcultivation. The soils which remain are stony, thin, and ill suited to agriculture. Flat or gently rolling upland areas are almost completely absent. Along the rivers and smaller streams are narrow strings of flat land which have been formed by alluvial deposition. The soils of a number of these valleys are fertile, but for the most part they are also stony or sandy.

The Development of Çiftçi Agriculture in the Çukurova

Çiftçi agriculture, as defined in this study, first appeared in the Adana and Tarsus areas about the time of the First World War. The *çiftçi* had been in most cases a villager. However, as a result of some favorable condition, he was able to successfully market one or several of his crops and save some of the cash return. Perhaps his village was near Adana or Tarsus and he was able to sell his fruits and vegetables to the expanding urban population. Perhaps the Mersin-to-Adana railway passed near his village and he could market some of his cotton. Perhaps he made a favorable marriage and the size of his land holding was increased. Whatever the cause, the result was an accumulation of capital. As a villager's wealth increased he was generally able to find others who, for some reason, were either willing or forced to sell some or all their land to him and he could increase the size of his land holding.

The Distribution of Çifçi Agriculture in the Adana Plain

A majority of the *çiftlik* of the Adana Plain are concentrated in three areas: (1) the Regma Gölü area south and west of Tarsus, (2) the lowlands south of the Tarsus-to-Adana highway and between the Seyhan and Tarsus Rivers, and (3) south of Adana between the Seyhan and Ceyhan Rivers (Figure 2).[2] Scattered *çiftlik* are also located along the railway northeast of Tarsus and near the left bank of the Ceyhan River near its mouth. The coastal area between the mouths of the Seyhan and Ceyhan Rivers and the more rolling country northeast of Adana are nearly devoid of *çiftlik*.

The concentration of *çiftlik* within a small number of villages in these areas is a prominent feature of rural settlement. Villages such as Firen-

[2] Data indicating the size and location of the *çiftlik* in the Çukurova was made available to the writer by the Agricultural Agents of Seyhan and Içel Provinces. They obtained it by special survey during the Summer of 1957.

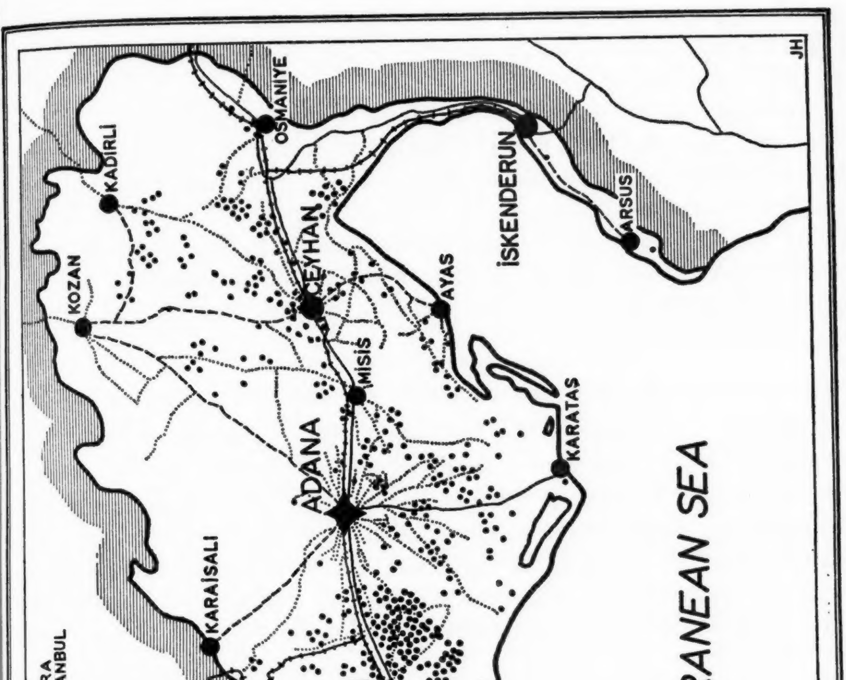

ÇIFTLIK AND TRANSPORTATION
ÇİFTLİK
RAILROADS
HIGHWAYS
SECONDARY ROADS
VEHICLE ROADS
N
0 10 20
KILOMETERS
TO ANKARA AND ISTANBUL
KARAISALI
KOZAN
KADIRLI
OSMANIYE
CEYHAN
MISIS
ADANA
AYAS
İSKENDERUN
ARSUS
KARATAŞ
TARSUS
MERSİN
SİLİFKE
MEDITERRANEAN SEA
JH

FIG. 2

gülüs (Tarsus Bucak) with fourteen *çiftlik*, Tiznik (Tarsus Bucak) with eight, and Reşadiye (Tarsus Bucak), Alifaki (Tarsus Bucak), and Mehmandar (Adana Bucak) with seven each, contain little non-*çiftçi* agriculture. On the other hand, a majority of the villages of the area contain no *çiftlik* whatsoever.

More than ninety percent of the *çiftlik* of the Adana Plain are smaller than 660 hectares (1,482 acres) although there are six larger than 1,000 hectares (2,470 acres) within the area. For the most part, these holdings are not fragmented as are many of the villagers' holdings. The larger *çiftlik* are located chiefly in the recently reclaimed areas along the lower Seyhan and Ceyhan Rivers, whereas many of the smaller ones are concentrated along the major transportation arteries and on the slightly higher interstream areas.

Factors in the Development of Çiftçi Agriculture in the Adana Plain

Although a number of the individual villagers in the Adana Plain originally became *çiftçi* as a result of one or more fortuitous circumstances, several factors are present in the Plain which have further encouraged the development of *çiftçi* agriculture. The relatively favorable climate and the rich soils of the Plain, the modification of Islamic inheritance customs, and government financial and technical aid to the farmer no doubt have contributed generally, but none of these is confined to the area.

Three factors have specifically encouraged the development of commercialized *çiftçi* agriculture in the Adana Plain. These are (1) the presence and rapid development of a more adequate transportation system, (2) the growth and increased accessibility of the farmer to commercial markets for agricultural produce, and (3) some opportunity for the accumulation of surplus capital by owners of agricultural land.

Transportation

The development of more adequate transportation facilities has been one of the major changes in the Adana Plain during the past several decades. Eighty-five years ago travelers noted the paucity of roads both within the area and connecting it with other parts of Turkey.[3] The first railway in the Çukurova was constructed during the 1880's, but the line

[3] Davis reported in 1878 that ". . . there is but one road in Cilicia [the Çukurova], that between Mersina, Tarsus, and Adana. . . . The road is slightly made, but as very few wheeled vehicles are employed there is not much wear. Beyond Adana there is absolutely no road, and so bad is the communication that produce can only be brought down to the coast at great cost and with much delay, the transport camels often sinking up to the belly in mud and water." E. J. Davis, *Life in Asiatic Turkey* (London: Edward Stanford) 1879, p. 28.

connecting the Çukurova with Istanbul and the cities of the Central Plateau was not completed until the First World War.

During the decade immediately preceeding the Second World War and since the War, numerous additions have been made to the area's highway network. The original Mersin-Tarsus-Adana road has been paved and hard surface roads have been constructed to Karataş, Misis, and through the Toros to Ankara (Fig. 2). All-weather roads have been built between Adana and Karaisali, between Adana and Kozan, and on the levees along the Seyhan and Ceyhan Rivers. Other roads, principally in the vicinity of Adana, which are passable for motor vehicles for much of the year, have also been constructed. Trails, passable for trucks and jeeps only during the summer dry season, connect numerous other villages of the Plain with these roads and major highways.

The original development of *çiftçi* agriculture in the Plain was directly dependent upon the development of an adequate transportation net. Most of the villagers who first became *çiftçi* were located either within walking distance of one of the Plain's cities or the railway which connected them. On the other hand, the development of *çiftçi* agriculture in other sections of the Plain was retarded until all-weather roads were constructed.

These improved transportation facilities have benefitted those farmers located near them in several ways. Firstly, the movement of their agricultural produce into the cities is easier, more rapid, and less costly than for those farmers in more isolated areas. Hence their margin of profit is often greater. Secondly, the time required and the difficulty of transporting their produce to other sections of Turkey have decreased. As a result, the growing markets in Istanbul and Ankara can now be exploited and more easily supplied with agricultural commodities from the Çukurova.

Markets

The growing demand for the agricultural produce of the Adana Plain and the construction of marketing facilities in the area's cities have provided the second stimulus to the accumulation of land.

The rapidly expanding population of the Çukurova's cities has provided a major stimulus to the cultivation of food crops such as vegetables, fruits, wheat, and rice. Adana, which has doubled its population since 1940, is the principal market, although Tarsus, Mersin, and several of the smaller towns contain growing non-farm populations.

No accurate measure of the proportion of the agricultural produce of the Plain needed to feed the area's urban population or the actual amount of produce entering this market is available. However, crude estimates, based upon the per-capita consumption of certain foods in

Turkey, indicate that farms in the vicinity of Adana barely satisfy Adana's food requirements. These estimates also indicate that if the Çukurova were isolated from the remainder of Turkey the city would provide a market for a considerable proportion of the entire Plain's agricultural produce (excluding cotton).

A secondary demand for agricultural produce within the Plain is created by several manufacturing plants in Adana and Tarsus. The demand in these plants is for cottonseed for oil and seedcake and for cotton lint for yarn and textiles.[4]

The principal markets outside the Çukurova for the area's agricultural produce are in Turkey's major cities. The demand is greatest for cotton lint for the textile plants in Istanbul, Kayseri, and Bursa, and for vegetables, citrus fruits, melons, and wheat in the consumer markets in Ankara and Istanbul.

Some of the agricultural produce of the area also enters the channels of world trade either directly or through middlemen in Istanbul or Ankara. This amount fluctuates considerably from year to year, but if a surplus of a commodity, particularly wheat or cotton, is produced every effort is made to divert it to the foreign market.

The development of these markets has provided outlets for the increased production of the *çiftlik*. This in turn has encouraged the *çiftçi* to enlarge their holdings in order to produce still more, chiefly because the small farmers have not been able to increase production and satisfy any large part of this demand. This is particularly true for cotton, wheat, and rice. Coincidentally, the various marketing programs of the Turkish government and the agricultural cooperatives, the price-supporting program of the government-sponsored Toprak Mahsulleri Ofisi (Soil Products Office), and the credit program of the Ziraat Bankasi (Agricultural Bank) have further increased the ease of producing and marketing agricultural commodities for those farmers who have utilized these programs. Generally only the larger farmers have recognized their value and have been able to take advantage of them.

Capital

The opportunity for the accumulation of capital, which has been a relatively recent development in the Çukurova, is closely associated with the earliest development of *çiftçi* agriculture. Prior to the First World War the wealthiest groups in the Çukurova were city merchants—pri-

[4] The location of cotton mills in Adana came chiefly after the area had achieved a dominant cotton producing position and reflects both the policy of the Turkish government to disperse industrial plants throughout the country and the tendency of plants of this type to locate near their principal source of supply.

marily Greeks and Armenians, but also a considerable number of Turks—the state, and the church. All had accumulated large capital reserves in trade and finance and controlled the marketing facilities for agricultural produce. However, the departure of the minority groups at the time of the First World War and in succeeding years, the confiscature of church lands, and several years of rebellion and foreign occupation reduced their importance and influence in the rural areas.

During the two inter-war decades those who were first able to accumulate land were also the first to accumulate surplus capital. As the numbers of *çiftçi* gradually increased the amount of capital accumulated also increased. A larger part of this accumulated capital was invested in more agricultural land during the 1930's and during the early part of the 1940's. This investment of capital in more land continued at a rapid pace until the individual farmer and his family could no longer farm with primitive agricultural tools and the simplest mechanized farm equipment. Then a portion of the capital invested was shifted from the purchase of land to the purchase of mechanized agricultural equipment, which conveniently was becoming more readily available during the late 1940's, and to the construction of drainage and irrigation projects.

The purchase of modern mechanized farm equipment increased rapidly in the years immediately following the Second World War. In 1944 less than 1,000 tractors were in operation in all Turkey.[5] Six years later double that number were in operation in the Çukurova alone.[6] The number of combines, threshing machines, mowing machines, plows, and disks also increased during the same period. Since 1950 the amount of all types of mechanized farm equipment has increased rapidly, particularly in those sections of the Çukurova where farms were relatively unmechanized in 1950.

Although the relationship of mechanization of agricultural production and the size of the land holdings has not been measured quantitatively, the generalization can be made that as the size of the land holding increases the amount of mechanized equipment on the farm also increases. Firengülüs village, for example, which contains more *çiftlik* than any other village in the Adana Plain, also contins a larger amount of mechanized farm equipment (Table 1). However, within the village a large proportion of the farm equipment is located on farms fifty hectares (124 acres) or larger. The majority of the families of the village, who either are landless or who farm small plots of land, operate considerably less

[5] G. E. Brandow, *Agricultural Development in Turkey*, Foreign Operations Administration (Ankara, 1953), p. 22.

[6] *1950 Ziraat Sayimi Neticeleri*, unpublished files in Central Statistical Office, Agricultural Division, Ankara, Turkey.

TABLE 1. ASSOCIATION OF LAND HOLDING AND TRACTORS IN SELECTED VILLAGES IN TARSUS BUCAK, 1957

Size of Holding	Number of Families	Number of Tractors
Firengülüs village		
250 Hectares or more[a]	2	9
150–249 Hectares	4	6
100–149 Hectares	8	11
50– 99 Hectares	13	11
50 Hectares or less	140[b]	15
Yunusoglu village		
250 Hectares or more	0	0
150–249 Hectares	3	2
100–149 Hectares	1	0
50– 99 Hectares	12	10
50 Hectares or less	104[b]	7
Hasan Aga village		
250 Hectares or more	0	0
150–249 Hectares	4	8
100–149 Hectares	0	0
50– 99 Hectares	2	2
50 Hectares or less	41[b]	4

[a] 1 Hectare = 2.47 acres.
[b] The number of families with land holdings of fifty hectares or less was computed by dividing the total population of the village by the mean family size in the Bucak and then subtracting the number of families with land holdings of fifty hectares or larger.
Source: Personal communication with agricultural agent of Içel Vilayet, Mersin, Turkey.

mechanized farm equipment than the large landowners. A similar distribution is evident within other villages in the area.

The *çiftçi* have also invested extensively in irrigation facilities. Schemes such as the Tarsus-Berdan Project, designed to irrigate 30,000 acres; the Seyhan River Right Bank Project, designed to irrigate 133,000 acres; and the Seyhan River Left Bank Project, designed to irrigate over 247,000 acres have either been placed in operation or are in the planning stage.[7] These have added, and will in the future add, significantly to the Çukurova's irrigated area and potential agricultural production.

The *çiftçi* of the Adana Plain have been willing to invest their surplus capital in these irrigation projects for several reasons. The primary one is their desire to increase the yields of their crops and to guarantee a minimum return per acre of agricultural land. However, a second motive to invest has been the desire on the part of the *çiftçi* to concentrate their agricultural production on the cultivation of crops such as cotton,

[7] Turkish Republic, Ministry of Public Works, General Directorate of State Hydraulic Works, *Irrigation System in Turkey–Available and Contemplated* (Ankara: Güzel Istanbul Matbaasi, 1957), pp. 6, 9.

sesame, and rice which generally command a higher return on the commercial market and which need irrigation water for completely successful cultivation.

The *çiftçi* of the Adana Plain have not confined their investments to agriculture. They have also invested substantial amounts of capital in the area's cities. A large part of the new residential construction in Adana and Tarsus has been financed with *çiftçi* money. Several *çiftçi* have become city merchants. Others have invested substantial amounts of capital in cotton gins, small textile plants, and grain mills.

Çifiçi Agriculture in the Yukari Ova

Although *çiftlik* are located in all parts of the Yukari Ova, they are concentrated in three areas (Fig. 2). The concentration which contains the largest number of *çiftlik* lies on both banks of the Ceyhan River in the vicinity of Ceyhan (city). A second concentration lies several miles northeast of Ceyhan (city) north of the Adana-to-Iskenderun rail line. The third major concentration is located south of Kadirli. Scattered *çiftlik* are found outside these three areas near Osmaniye and south of Kozan.

The *çiftlik* of the Yukari Ova, like those in the Adana Plain, tend to be concentrated in relatively few villages. For example, five of the twenty-two *çiftlik* in Kösreli Bucak (northeast of Ceyhan city) are in or near one village and nine of the fifty-five *çiftlik* in Ceyhan Bucak are in or near Ceyhan (city).

The same general factors (transportation, markets, capital) which are present in the Adana Plain and favor the development of *çiftçi* agriculture there, are also operating in the Yukari Ova. However, the favorable aspects of the three factors are not as well developed as in the Adana Plain and the accumulation of land into *çiftlik* has been somewhat retarded.

The most notable deficiency in the Yukari Ova is the lack of a completely developed transportation network. Roads, as such, were nonexistent until the early years of the twentieth century. Railway construction began about the same time. Roads from Ceyhan (city) to Kozan and Kadirli have been constructed only in the last twenty years, and improved only in the last ten. Farm-to-market roads are for the most part impassable during much of the year or are completely absent.

In addition to this shortage of transportation facilities, the Yukari Ova contains no large urban market, few city-oriented marketing facilities, and few manufacturing plants which demand local raw materials. Thus the number of farmers who have been able to successfully market their agricultural produce, accumulate capital, and invest in larger amounts of

land is significantly smaller than in the Adana Plain. However, the number of *çiftlik* is now expanding as rapidly as it has been in the Adana Plain for the past several decades.

Çiftçi Agriculture in the Remainder of the Çukurova

Çiftçi agriculture is absent in much of the remainder of the Çukurova. Land accumulation has taken place only in the northern portion of the Plain of Iskenderun and in the rolling foothill country northeast of Tarsus (Figure 2).

The most significant factor which has restricted land accumulation in much of this area is the terrain. Large amounts of relatively level and arable land are found in few areas. Considerably rougher land separates these from each other and from the two larger lowlands. The lack of large amounts of crop land available for purchase and the difficulties of central management and mechanized agriculture even in the more level areas decrease significantly the prospects for *çiftçi* agriculture.

The lack of transportation facilities has provided a second deterrent to land accumulation. Most of the area is, or has been until the last several years, isolated from the outside world. However, with the exception of the northern portion of the Plain of Iskenderun, little land accumulation has taken place even where transportation has been available.

The third factor which has retarded the development of *çiftçi* agriculture is the relative ease of irrigating agricultural land with small, crudely constructed irrigation systems. Gradients are steep, plots are small, and capital investment is low. The ease of irrigation has favored the commercial cultivation of orchard and garden crops which require large amounts of hand labor and yield relatively high returns per acre, and the need to expand land holdings and to mechanize to increase production has not been felt.

The Prospects

During the past several decades the accumulation of land into *çiftlik* has been extremely rapid. Large tracts of land which had either been unfarmed or had been divided into small land holdings have been developed into major producers for the commercial market. Will this trend continue? Will *çiftçi* agriculture become the principal type of agricultural occupance? These questions cannot be definitely answered. The trends which have resulted in this type of agricultural development are of too recent origin and the assumption cannot be made that they will continue to function. Statistics, particularly before 1950, are incomplete and possibly provide only a partial picture of the situation. The role of historical chance or accident in this particular situation is not yet completely

known. However, a number of observations about possible future developments can tentatively be made.

(1) In the sections of the Çukurova where large scale irrigation works are now coming into operation or will be completed in the very near future, the size of the land holdings will probably continue to increase. A large land holding is generally a prerequisite for participation in these irrigation schemes because of the high initial capital investment and the relatively high cost of maintaining the irrigation (and drainage) facilities in most areas included in these projects. Only if the government makes capital available to small land holders or provides help with the construction of side ditches and canals will this situation be modified.

In the parts of the Çukurova where large-scale irrigation works are not planned or under construction, but where transportation is adequate (*i.e.* in sections of the Yukari Ova), and where substantial economies and relatively high returns result from extensive dry farming operations, the size of the land holdings will also continue to increase.

(2) In areas where small scale irrigation projects and individual farmer gravity irrigation systems are predominant (on the Plain of Erdemli, in the vicinity of Mersin, and along the western slopes of the Amanus Mountains) the size of individual farms will probably remain relatively small, since less capital investment in irrigation facilities is required.

(3) In the peripheral foothills, and in the other less accessible sections of the Çukurova, the size of land holdings will remain small since few opportunities exist to accumulate capital to invest in land.

These trends could, of course, be altered by radical shifts in the political status of the countries of the Middle East. Plant diseases and pests could destroy any of the area's crops, restrict their continued cultivation, and lead to shifts in land ownership patterns. Major shifts could occur in the markets for the Çukurova's produce.

The agriculture of the Çukurova is most likely to be altered by changes in the policies and programs of the Turkish government. Price-support and marketing programs could be radically changed or modified. Tax laws could be rewritten. New marketing and processing facilities could be constructed by the government.

The government policy change which would most affect the area's agricultural development and the accumulation of land would be the enforcement of the existing land tenure laws, or the passage of new ones. The law which requires the division of excessively large land holdings into smaller holdings could be enforced. The decision could conceivably be made that the intensive production of crops on small holdings is socially more desirable than the present mixed system.

These actions, however, are not likely under existing economic and

political conditions in Turkey for several reasons. (1) The country's expanding population is demanding larger and larger amounts of food. The villagers have demonstrated in the past that they cannot supply this expanded demand. (2) The government's need for foreign exchange is great. This need, as in most agrarian economies, can be met only by exporting surplus agricultural commodities. This surplus is available only from large farms. (3) The *çiftçi* of the Çukurova have provided a considerable part of the badly needed investment capital in post-war Turkey. The government is not likely to stifle this source of funds. (4) The major disadvantages of land accumulation in the Middle East—absentee ownership, mining of the soil, excessive rents and fees—have until now been held in check in the Çukurova. Land accumulation has often resulted in better land practices. Greater amounts of cash circulating in the rural economy have furthered irrigation and mechanization. Semi-employed villagers who have been forced off the land into the cities have formed an urban labor pool. Increased urban population has expanded the demand still further for agricultural produce. Only when economic conditions stabilize or when the disadvantages of land accumulation far exceed the advantages is organized action likely to be taken.

RECLAMATION UNDER THE DESERT LAND ACT, 1954-59

Karl S. Landstrom*

MY EARLIER article[1] on the Desert Land Act[2] traced developments from 1877 through 1953, and discussed the prospects, as they appeared at the time, for further reclamation of arid lands under the Act. It was stated that desert-land entries are speculative ventures, and that the future trend of activity would be greatly influenced by the record of success being made on the then-existing entries.

Recent progress under the Act has exceeded the expectations outlined in my earlier article. At the same time many failures have occurred, and large scale promotional activities under the framework of the Act, in States such as California and Nevada, have caused severe losses to the public and have increased Government administrative costs, without corresponding increases in actual reclamation.

Extent of Recent Activity

Activity under the Act since 1953, as in the earlier period, has been stimulated by higher real-estate values of irrigated lands and by favorable income opportunities in irrigated agriculture. Greater efficiencies in well drilling and pumping, further extensions of rural electric lines, and further improvements in facilities for desert living are among factors contributing to sustained interest in reclaiming desert lands.

Excellent economic progress has been made by some entrymen in the State of Idaho, for example, but many in that State have had unsatisfactory results. In reporting on this, Kimball[3] concluded that the chief result under the Act in Idaho in recent years has been the formation of new, large-scale, efficient farms, averaging more profitable than irrigated farms generally in the State. The chief problem facing entrymen and would-be entrymen in Idaho was found to be a lack of information concerning requirements of the law and regulations and the characteristics of the available land and water resources. Farms developed in the Hazelton-Butte Area, north of the Snake River, between Twin Falls and Burley, averaged 263 acres of irrigated land, and in 1956 returned an average net cash income of $17,321 per farm. The average capital invested was

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[1] Karl S. Landstrom, "Reclamation Under the Desert-Land Act," *J. Farm Econ.*, 36:500-08, Aug. 1954.

[2] Act of March 3, 1877 (19 Stat. 377), as amended (43 U.S.C., secs. 321-3).

[3] N. D. Kimball, *Irrigation Development in Idaho Under the Desert Land Act*, Idaho Agr. Exp. Sta. Bul. No. 292, Dec. 1958.

$33,703. Water was being pumped from about 360 feet without apparent effect on the level of the underground flow of water.[4] In another Idaho area, south of Burley, the Bureau of Land Management has proceeded with caution because of doubtful water supplies, objections from owners of existing irrigation wells, and competition from grazing or other land uses. Allowances by the Bureau of new entries in Idaho have fallen off sharply, and this trend is expected to continue.

In Utah, to take another example, many failures have occurred and costs or losses of capital have been high in some instances. In reporting this, Stewart[5] also pointed to lack of information as a primary cause of difficulty, and said that much additional public land in the State could be transferred to private ownership under the Act if satisfactory water supplies could be found. He concluded that failures, losses, and administrative difficulties will continue to occur unless measures are taken to alleviate them.

In Nevada, as of 1957, there were 110,000 acres of first quality lands that were capable of being reclaimed through pumping under the existing cost and return situation, according to Mason and Wood.[6] From July 1, 1957 to June 30, 1959, the Bureau of Land Management allowed 236 new entries in the State, comprising 55,981 acres of land. Increased promotional activity has occurred in Nevada. Dissatisfaction with the operations of out-of-State promoters offering to assist persons in applying to the Bureau of Land Management has been expressed by Nevada residents, and the Nevada Legislature has memorialized the President and the Congress to amend the Desert Land Act so as to eliminate the exception of Nevada from the provision that no person shall be entitled to make an entry unless he is a resident of the State in which the land is situated.[7]

In California, allowance of new desert-land entries was discontinued by the Bureau of Land Management for a temporary period when it was thought that a ruling of the Solicitor of the Department of the Interior concerning water rights in Arizona[8] was applicable in California. Meanwhile, applications continued to be received. In 1959, out of some 6,000

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[4] *Id.*

[5] Clyde E. Stewart, "Homesteading in the Nineteen Fifties," *Farm & Home Science,* 20:14-16, March 1959.

[6] Howard G. Mason and Garland Wood, *New Lands from Ground-Water Development,* Nevada Agr. Exp. Sta. Bul. No. 194, June 1957.

[7] Nevada State Senate Joint Resolution No. 1, adopted by the Nevada Legislature May 25, 1959. An Executive Communication recommending enactment of such a measure and repeal of the Pittman Act of October 22, 1919 (41 Stat. 293; 43 U.S.C., secs. 351-355, 357-360), was submitted by the Department of the Interior to the Congress on June 16, 1960.

[8] Opinion, Solicitor, Department of the Interior, M-26263, Feb. 23, 1955.

applications then pending, only 13 new entries were allowed to be made on public lands in the State, aggregating 2,299 acres. At a recent date, some 5,000 applications, each involving up to 320 acres of land, were pending in the Los Angeles Land Office.

Misinformation that the reclamation requirements of the Desert Land Act could be waived or avoided by means of offering to purchase the land at an increased price has been widespread in California.[9] The promotional activities of professional services, called "land locators," have been cited by the Bureau of Land Management as a source of misinformation on this and other points. By an act of the 1959 California Legislature, the State Business and Professional Code was amended so as to include within the definition of "real estate broker" any person who for compensation assists or offers to assist another in filing an application for the purchase or lease, or for the entering or locating, of Federal or State land.[10] Penalities are provided under the Code for the publication of false statements or for false advertising.

Recently the Bureau of Land Management, with the approval of the Office of the Secretary of the Interior, has classified extensive areas of California lands as "unsuitable for desert land entry." The classifications were accompanied by rejections of desert-land applications in over 1,500 cases. Further unfavorable classifications of land and rejections of applications may be anticipated where the land and water resources involved do not have a demonstrated capability for sustained economic operation.

The effect of the Solicitor's opinion, affecting public lands in Arizona, has been to cause the rejection of all new applications based on percolating ground water.[11] Some activity is continuing in Arizona under the general homestead laws, to which the Solicitor's opinion did not apply.

Lesser volume of activity under the Act has continued in other public-land States to which it is applicable—Colorado, Montana, New Mexico, Oregon, Washington, and Wyoming. Increased activity is not now expected in those States unless promotional activities are accelerated.

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[9] The ordinary price of land under the Desert Land Act is $1.25 per acre. Under certain so-called "relief" acts, the purchase of land at a price aggregating $5.00 per acre was authorized without requiring that the reclamation and irrigation of the land be completed, but these laws have no application to entries that have been made since July 1, 1925. See 43 CFR 232.39 to 232.58.

[10] California Business and Professional Code, secs. 10131 and 10132.

[11] The Solicitor's opinion, referred to in footnote 8, held that under a decision of the Arizona Supreme Court (*Bristor v. Cheatham*, 75 Ariz. 227, 225 P. 2d 173, 1953), percolating ground waters not comprising an underground stream with well-defined channel and banks are not subject to use under the appropriation doctrine of water rights, and thus are not satisfactory within the provisions of the Desert Land Act. Under the Act of August 4, 1955 (69 Stat. 491), the reclamation and final proof of desert-land entries entered before and subsisting on the date of enactment of the act was authorized notwithstanding the deficiency in water right under the opinion.

TABLE 1. ORIGINAL ENTRIES[1] ALLOWED AND FINAL ENTRIES[2] APPROVED UNDER THE DESERT LAND ACT, JULY 1, 1947–JUNE 30, 1959

Year Ending June 30—	Original Entries Allowed		Final Entries Approved	
	No.	*Acres*	*No.*	*Acres*
1948	56	7,159	14	1,733
1949	78	12,250	25	3,153
1950	146	26,834	60	9,888
1951	224	44,687	75	10,593
1952	165	29,255	47	6,579
1953	256	49,982	76	13,451
Total, 1948–53	925	170,167	297	45,397
1954	731	182,200	83	11,095
1955	486	119,233	100	15,667
1956	315	75,902	148	26,434
1957	330	77,431	140	25,949
1958	156	32,692	191	36,903
1959	180	41,707	186	38,603
Total, 1954–59	2,198	529,166	848	154,651
Total, 1948–59	3,123	699,333	1,145	200,048
Average acres per entry, 1948–59	—	224	—	175

[1] "Original entry" is an entry in connection with which the entryman must comply with further requirements of the public land laws before a final certificate may be issued. A "final certificate" evidences that an entryman is entitled to a patent if no irregularities are found in connection with the entry.

[2] "Final entry" is an entry in connection with which a final certificate has been issued.

Compiled from annual reports of the Bureau of Land Management.

Analysis of Recent Activity

Allowance of new entries by the Bureau of Land Management reached a peak in fiscal year 1954 of 731 entries, embracing 182,200 acres, and has since declined (Table 1). The number of final entries approved by the Bureau continued to increase after 1954, as would be expected as the "original" entries became reclaimed and developed so as to reach the stage of final proof.

The average size of original entries during twelve years, 1948-59, was 224 acres. The average size of final entries approved was 175 acres. Elimination of acreage occurs in many entries at time of final proof so as to exclude lands that could not be developed because of soil conditions, limited supply of water, or other reasons.

In the twelve-year period, final entries approved for patenting totalled 1,145 consisting of 200,048 acres. It is reasonable to assume that a satisfactory water source and water distribution system had been provided for all of the irrigable lands within these entries, as required by law. During the twelve years, unestimated areas of additional lands had been reclaimed or partially reclaimed under the Act within entries for which final certificates had not yet been issued. Thus, within the twelve years,

TABLE 2. ORIGINAL ENTRIES ALLOWED, FINAL ENTRIES APPROVED, AND PUBLIC LANDS CLASSIFIED AS SUITABLE AND NOT SUITABLE FOR DISPOSITION UNDER THE DESERT LAND ACT, JULY 1, 1953–JUNE 30, 1959

State	Original Entries Allowed		Final Entries Approved		Public Lands Classified		
					Suitable for Disposition	Not Suitable for Disposition	Total
	No.	*Acres*	*No.*	*Acres*	*Acres*	*Acres*	*Acres*
Arizona	119	34,733	77	19,187	96,074	114,528	210,602
California	346	84,850	116	15,596	171,297	614,849	786,146
Colorado	13	2,849	21	4,431	5,436	5,477	10,913
Idaho	888	215,588	463	88,600	222,585	186,145	408,730
Montana	4	840	3	590	997	1,795	2,792
Nevada	443	108,622	34	7,620	138,240	339,936	478,176
New Mexico	43	11,349	11	1,757	25,427	49,296	74,723
Oregon	103	24,095	21	2,300	30,256	13,078	43,334
Utah	100	20,036	35	5,620	20,320	39,174	59,494
Washington	0	0	9	806	280	183	463
Wyoming	139	26,203	58	8,144	30,280	8,817	39,097
Total	2,198	529,166	848	154,651	741,192	1,373,278	2,114,470

Individual items may not add to totals because of rounding from fractional acreages. Compiled from annual reports of the Bureau of Land Management.

reclamation development had occurred through private initiative and investment on probably well over 200,000 acres of public land.

By comparison, under the Federal reclamation program, administered by the Bureau of Reclamation, the total of all homestead opportunities during thirteen years, 1946-58, was 2,842 farm units consisting of 264,240 acres.[12] The large potential demand for settlement of farm families on irrigated farms developed from public lands is indicated by the fact that 134,620 applicants applied for the 2,842 farm units made available for homesteading under the Federal reclamation program from 1946 through 1958.[13]

Fewer desert-land entries reached the stage of final proof in the period 1954-59 than ordinarily would have been expected because of the operation of a relief act, the Act of July 30, 1956 (70 Stat. 715), under which any entryman could make a temporary suspension of cultivation and improvement operations for a period ending on March 1, 1959.

During the 1954-59 period, a total of 741,192 acres of public land was included in areas classified by the Bureau of Land Management as suitable for disposition by means of entries under the Act (Table 2). A noteworthy rise in favorable classifications occurred in Nevada. The increased level of applications in Nevada has been attributed partly to the transfer of activity of promoters from Arizona, following the closing of public

[12] "Reclamation—Accomplishments and Contributions," Committee Print No. 1, House Comm. on Interior and Insular Affairs, 86th Cong., 1st Sess., Jan. 1959, p. 21.
[13] *Id.*

lands in the latter State to desert entry based on percolating water rights under the Solicitor's opinion, referred to.

In the 1954-59 period, nearly twice as much public land was classified as not suitable for desert-land entry as was classified suitable. This reflects a continued over-optimism on the part of applicants as to the capability of the land resources applied for, or as to the willingness of the Bureau of Land Management to make the lands available under the Act in view of competing applications or uses for the same lands, such as for grazing, small-tract home or business sites, recreational uses, or various conservation or administrative uses of the Government itself. Applicants often do not realize that there may be competing applications for the same land, or petitions by users of the same lands that they be retained in Federal ownership for multiple-use administration. The effect of a negative classification is that the land remains in a temporarily withdrawn status, as provided by section 1 of the Taylor Grazing Act[14] or the applicable general orders of withdrawal.[15] The land remains reserved for conservation of natural resources but it continues to be available for the filing of applications and for disposition under the nonmineral public land laws if favorably classified.

As of June 30, 1959, there were 1,768 unperfected desert-land entries pending in offices of the Bureau of Land Management, involving 444,601 acres of land. A few of these entries have remained unperfected for several decades.

Promotional Activity

The regulations of the Department of the Interior governing the filing of desert-land entries[16] have long made it clear that the policy objective of the Desert Land Act is to encourage the actual reclamation for agricultural purposes of arid or semi-arid public land through individual efforts and by the use of private capital. Misunderstanding that the objective is actual reclamation has been widespread, particularly along the line that the Act has loopholes under which land can be obtained at a nominal price without actual reclamation development. This is not altogether a new occurrence, since, as Clawson and Held have put it, the Desert Land Act "has been widely criticized because it readily lends itself to fraud and misrepresentation."[17]

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[14] Sec. 1 of the Act of June 28, 1934 (48 Stat. 1269), as amended (43 U.S.C., sec. 315).

[15] Executive Order 6910 of November 26, 1934, and Executive Order 6964 of February 5, 1935.

[16] Regulations issued under the Desert Land Act are published in Title 43, Code of Federal Regulations, Chap. 232. Other chapters of Title 43 pertinent to desert-land entries include Chapters 1, 101, 102, 106, 160, 161, 181, 221, and 296.

[17] Marion Clawson and Burnell Held, *The Federal Lands, Their Use and Management*, The Johns Hopkins Press, 1957, p. 108.

It has been said that many people living in the Southwestern United States are interested in acquiring almost any type of low-cost rural land, perhaps as a hedge against some ill-defined personal contingency, as a possible retirement or recreational site, or as a means of speculation or a hedge against inflation of the currency. This type of person is easily attracted by the advertising claims of public land "locators" concerning the operation of the Desert Land Act.

The great potential demand for public land in desert regions is more easily understood when it is realized that rural real estate in such Western areas is predominantly in Federal ownership. As of June 30, 1959, the percentage of surface held in Federal ownership in certain States was, in Utah 69 percent, Idaho 64 percent, Oregon 51 percent, Wyoming 48 percent, California and Arizona 45 percent, Colorado 36 percent, and New Mexico 35 percent.[18] It is observable, however, that in valley or basin areas in which desert-land applications have been filed in great numbers there is usually considerable acreage of privately owned land of similar character remaining undeveloped.

The attractiveness of the fixed price of $1.25 per acre under the Act must be viewed in the light of the legal requirement that an entry cannot be made (application cannot be allowed) unless the land is first classified by the Bureau of Land Management as being "more valuable or suitable for the production of agricultural crops than for the production of native grasses and forage plants,"[19] and of the requirement, assuming that the original entry is allowed, that the land must be provided with a complete and adequate supply of irrigation water, held under a satisfactory water right, for the continuous irrigation of all of the irrigable area within the entry. It is well known that the cost of an irrigation well and plant capable of providing a satisfactory water supply to 320 acres of desert lands in typical Southwestern desert areas runs into the tens of thousands of dollars.

The technical nature of the information required to be filed with a valid desert-land application understandably tends to cause prospective applicants to turn to the services offered to them by professionals. It is clearly required by the law and the regulations, however, that the applicant personally examine every legal subdivision of the land applied for and satisfy himself that the land can be reclaimed and farmed as contemplated in the application.

The Bureau of Land Management has stated that scores of people have

[18] General Services Administration, Inventory Report on Real Property Owned by the United States Throughout the World As of June 30, 1959, U.S. Govt. Print. Off., p. 20.

[19] Sec. 7 of the Act of June 28, 1934 (48 Stat. 1269), as amended (43 U.S.C., sec. 315f).

asked Bureau offices concerning the validity of the services offered to them by "locators." The Bureau has repeatedly announced to the public that the Federal Government does not license or regulate such persons or firms, and does not require anyone to hire their services. It has warned the public that some operators have engaged in promotions that border on fraud.

In many reported cases, applicants have confused the fee asked for or paid to the locator as a part of the purchase price of the land. An insidious practice has been the provision in many locator contracts under which the entire service fee, in some cases running as high as $10 per acre, became due and payable upon the "acceptance" of the application by the land office. Only later, when the application was rejected, did many applicants realize that "acceptance," in land office parlance, meant merely that the application papers had been received in the mail or had been taken in over the counter at the land office. A public announcement of the Bureau of Land Management has stated that realtors, in the ordinary course of private land transactions, fail to earn a brokerage fee until the buyer and seller of the land reach an agreement. The release suggested that public land applicants might well withhold payment of a locator's service fee, at least in part, until the application had been allowed.[20]

Outlook

In view of abuses caused by excessive promotional activities as referred to, the administration of the Desert Land Act is undergoing a severe reappraisal within the Government. The recent large-scale rejections of desert-land applications in California, and the related new administrative practice of refusing to receive further applications for unfavorably classified lands, have been referred to as being "almost a world-shattering circumstance,"[21] referring, of course, to the history of recent administration of the vacant public lands. Related to this is a renewed interest looking toward the enactment of modernized public land laws.

As indicated above, many of the thousands of applications filed under the Desert Land Act were directed toward nonagricultural purposes in the use of land. A need exists for public land laws that would directly permit the lease and sale of public lands that are chiefly valuable or suitable for urban, suburban, or industrial uses. Limitations contained within

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[20] The laws of the State of Nevada require that a fee paid to a real-estate broker be placed in a trust account and that the fee is not earned until the public-land applicant is permitted to enter or lease the land applied for. Nevada Real Estate Code, sec. 645.030.

[21] "Public Land Urban and Business Sites," Hearings before the Subcommittee on Public Lands, Committee on Interior and Insular Affairs, House of Representatives, 86th Cong., 1st Sess., on H.R. 7042, Serial No. 10, p. 48.

existing laws, such as the Small Tract Act[22] or the Public Sale Law,[23] render them ineffective in meeting this demand. Bills based upon a Departmental draft, prepared in response to a request of the House Committee on Interior and Insular Affairs made in 1957,[24] are pending in the 86th Congress.[25] Bills also have been introduced to establish a commission to study the nonmineral public land laws and recommend a more effective, simplified, and adequate system of laws governing the transfer of title to public lands.[26]

The need for more comprehensive and timely classifications of the public land has been recognized in an exchange of correspondence between the House Committee on Interior and Insular Affairs and the Department of the Interior.[27] In this correspondence, the Assistant Secretary of the Interior for Public Land Management stated that the Department of the Interior is "forced to operate under a crazyquilt patchwork of laws designed primarily to meet the needs of long ago." He said: "Some of these anachronistic public land laws invite spurious applications and permit the land locators and speculators to thrive. Other laws are drawn so narrowly they impair the proper disposition of lands."

Future administration of the Desert Land Act and related laws should adequately consider the serious and sustained depletion of underground water supplies that has already taken place in many Western areas,[28] together with the increasing competition from nonagricultural purposes for the use of available supplies of ground water. For example, the demand of outdoor recreation for the use of water in desert areas (as in the vicinity of Palm Springs) is increasing, and, as reported by Clawson,[29] the proper role of recreation as a user of land and water resources is difficult to measure. Decisions of the Department of the Interior have repeatedly held that classification of land as suitable for desert-land entry can properly be refused where the existence of an adequate supply of irriga-

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[22] Act of June 1, 1938 (52 Stat. 609), as amended (43 U.S.C., sec. 682a).

[23] Sec. 2455 of the Revised Statutes, as amended (43 U.S.C., sec. 1171), and the Act of July 30, 1947 (61 Stat. 630).

[24] "Small Tracts Act", Hearings Before a Special Subcommittee of the Committee on Interior and Insular Affairs, House of Representatives, 85th Cong., 1st Sess., Oct. 1, 1957, and Oct. 7, 1957, Serial No. 15, p. 3.

[25] H.R. 7042, H.R. 11626, and S. 1905, to authorize the classification, segregation, and disposal of public lands chiefly valuable for urban and business purposes.

[26] H.J.Res. 492 and S.J.Res. 130, 86th Cong.

[27] "Public Land Urban and Business Sites," *op. cit.* footnote 21, pp. 49-50.

[28] See "Water Availability—A National Problem?" and "Water Resources in the United States," Hearings before the Subcommittee on Irrigation and Reclamation, Senate Committee on Interior and Insular Affairs, on S.Res. 48, March 17, 1959, pp. 29-33, 45-52.

[29] Marion Clawson, "Methods of Measuring the Demand for and Value of Outdoor Recreation," Resources for the Future, Inc., Washington, D.C., Feb. 1959, p. 2.

tion water is not shown[30] or where the allowance of the entry would tend to aggravate an already serious water situation.[31]

The attitudes and interests of the desert-land applicants themselves, and those of other people in the local community, are of course major considerations in deciding upon the weight to be given to the favorable and unfavorable factors involved in the classification of public lands. In 1955, the Director of the Bureau of Land Management stated that the safeguarding of public interests and values involved in decisions on desert-land applications could usually be achieved by conforming to the recommendations of State and local government officials.[32]

The recent history of desert-land entries has been marked by many successes, but also by much uninformed or misinformed activity and many failures. Serious losses have been incurred by some persons, and increased Government costs have been incurred in handling large numbers of promoter-inspired applications.

Whether the Desert Land Act will continue as an aid toward the reclamation of public lands in the West will depend considerably upon the success of current efforts to improve the level of public understanding of capabilities and limitations under the Act, to reduce or control the promotional activities of unethical land locators, and to modernize generally the nonmineral public land laws. Local officials and leading citizens, however, are often in sharp disagreement among themselves as to the proper disposition of public lands.

The crucial importance of making sound classifications of public land is demonstrated in the case of the Burley, Idaho, grazing district of the Bureau of Land Management. In that district, desert-land applications pending in April of 1960, if all favorably classified and allowed, would require abandonment by the Government of more than 20,000 acres of successfully reseeded semi-desert range. Such abandonment would cause reduction of grazing by about 50 percent in three grazing units, involving more than 70 cattle and sheep ranches whose operators and their predecessors had made use of the Federal range and depended upon it for ranching stability for many decades.[33]

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[30] Decision of the Department of the Interior, Melvin W. Westwood, et al., A-26752, Aug. 20, 1954.

[31] Decision of the Department of the Interior, Joe B. Forehand, et al., A-26693, Dec. 9, 1954.

[32] "Desert Land Entries," Proceedings of the Fifteenth Annual Meeting, National Advisory Board Council, Bureau of Land Management, Washington, D.C., 1955.

[33] Letter, Director, Bureau of Land Management, to Rep. Wayne N. Aspinall, May 20, 1960.

NOTES

FARM PROGRAMS FOR FARM INCOMES*

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UP TO the present time, farm policy has been directed chiefly at supporting prices of farm products. Prices have been supported directly by commodity loan and storage programs, and indirectly by acreage reduction programs, including the soil bank.

These programs for supporting prices are based on the theory that supporting prices is the best way to support income per farmer—the thing that really counts.

This theory ignores the fact that prices are only one of the things that determine farm income; changes in quantities and costs can add to or can partly or more than completely offset the effects of changes in prices. Perhaps we could see the farm problem—which is basically a farm income problem—more clearly, and work out new and better solutions to it, if we were less preoccupied with prices, and concerned ourselves more directly with farm incomes.

First, then, how severe is the farm income problem? How low is the income of the American farmer, in dollars, and compared with incomes of people in other lines?

The most widely used answers to this question are based on good USDA statistics; but as several farm economists have pointed out, these statistics can be misleading.

Income Per Person on Farms

One answer is based on a comparison of income per person on farms[1] with income per person not on farms. These per person income figures for 1959 were: Farm, \$960; nonfarm \$2,202. The answer based on these statistics is that farm income is only about half as high as nonfarm income. This answer is the one that is most widely quoted when comparisons of farm and nonfarm income are made.[2]

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* Journal Paper No. J-3811 of the Iowa Agricultural and Home Economics Experiment Station, Ames, Iowa. Project No. 1346.

[1] *The Farm Income Situation,* AMS, USDA, July 1959, p. 39. Total United States net farm income from all sources divided by the total number of persons—men, women and children—on farms.

[2] See for example the chart and table in the *Agricultural Outlook Charts '60,* USDA, pp. 13 and 55.

The Census Definition of a Farm

These figures, however, understate the average farm income per person in the usual sense of the word farm, because "farm" in this case is "farm" as defined by the Census. This definition includes "farms" all the way down to 3 acres in size if the value of agricultural products exclusive of home gardens is $150 or more; it includes places of less than 3 acres if the value of *sales* of agricultural products is $150 or more.

Now most of the "farmers" on these small "farms" are not farmers at all in the ordinary sense of the term. Their chief source of income is a nonfarm job, not farming. About 1.7 million of these small farms are classed as noncommercial farms—part-time, residential, or subsistence farms. These are really acreages where city people live, rather than farms. They constitute more than a third of the total of 4.8 million farms of all kinds in the United States.[3] This large number of "not-really-farms" inflates the number of farms and farmers that is divided into the total United States net farm income, and therefore reduces the "average farm income" substantially below the average income for *commercial family farms* with the part-time, residential and subsistnce farms taken out.[4]

In 1956, these part-time and residential farms, nearly one third of all farms, made only 2 percent of all sales of farm products; "clearly, the welfare of the families on low-production farms is more closely linked with the expanding nonfarm sector of our economy than with agriculture as such."[5]

The same sort of thing is true if the dividing line is raised to include all low-producing farms, 55 percent of the total number of farms. "Families on the 2.8 million low-production farms with annual sales below $2,500 earn little income from farming, but their off-farm income is comparatively large" (farm, $789 per capita; nonfarm, $2,136 in 1956).[6]

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[3] Including them in the farm average is about like including in the average salary of professors numerous graduate students on their part-time stipends if these stipends were very small and the graduate students lived chiefly on other sources of income.

[4] E. W. Grove and N. M. Koffsky make this point clear in their article, "Measuring the Incomes of Farm People," *J. Farm Econ.*, 31:1110, Nov. 1949. So do K. L. Bachman and R. W. Jones, *Sizes of Farms in the United States*, USDA Tech. Bul. 1019, July 1950, p. 7, where they say that this "often gives rise to serious misconceptions," and show that excluding these non-commercial farms raises the average operator's net income 27 percent.

But Koffsky and Grove, in their later article, "The Current Income Position of Commercial Farmers," Joint Committee Print, *Policy for Commercial Agriculture*, Nov. 22, 1957, pp. 79-90, overlook the matter, and conclude on the basis of United States average data that "the level of income per person on farms has averaged roughly one-half of the non-farm level." This unwittingly gives support to the "serious misconception."

[5] *Economic Report of the President*, Jan. 1959, p. 99.

[6] *Ibid.*

Income Per Farm Worker

Another answer concerning relative farm and nonfarm income is based on a comparison of income per farm worker[7] with the average annual wage per employed factory worker. These per worker income figures for 1958 were: Farm $2,129; factory, $4,342. Conclusion: Income per farm worker is only about half as high as income per factory worker.

Income per farm *operator* was $2,990 in 1958. This is only about 69 percent as high as income per factory worker.

This situation appears to confirm the conclusion that is usually drawn from the per capita income figures given in the preceding section—that farm income is only about half as great as nonfarm income. But it, also, is misleading. The farm workers include the family workers, and the farm income includes a good deal of disguised partial unemployment, whereas the factory workers include only *employed* factory workers. The average-farm-worker's-income data therefore understate the actual average income much as the per capita income data do, partly for the same reason and partly for different ones.

Should Farm and Nonfarm Incomes be Equal?

The implication that usually goes along with the use of these farm and nonfarm income figures is that the two should be equal. D. Gale Johnson points out the fallacy in this:

> While one major farm organization believes that per capita incomes should be as high for the farm as for the nonfarm population, I know of no economist who holds this view. However, we must admit that we know far too little about the relative income levels that would be consistent with an efficient allocation of labor between agriculture and the rest of the economy.[8]

His calculations lead him to conclude that "if per capita farm incomes are 68 per cent of per capita nonfarm incomes, labor of equivalent earning ability would be receiving the same real returns in the two sectors of the economy. Because of the crudeness of the data and the estimating procedure, it might be safer to argue that the equivalent level is somewhere in the range of 65 to 70 per cent."[9]

Commercial Farm Income by Areas

We will get a more accurate measure of farm income if we compute the average income for *commercial family farms.*

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[7] *The Farm Income Situation, op cit.*, p. 40. This is total United States realized net farm income from farming, including government payments, divided by the total average number of persons engaged in agriculture during the year, including farm operators and other family workers (except those doing housework only) as well as hired workers.

[8] *Agricultural Adjustment Problems in a Growing Economy,* Iowa State University Press, 1956, p. 164.

[9] *Ibid.*

The USDA publishes another set of figures which show this income per commercial family farm, by types of farming in different areas. These figures are compiled differently from those given above. They do not show income per farm for the United States as a whole; they show income per commercial family farm for each of 32 chief types of farming, separately for each of the relatively homogeneous areas shown in Figure 1.

The average net income per farm for the past few years is computed separately for each area, and published annually in tabular form.[10] The unweighted average of these incomes was $7,238 in 1958.[11] This on the face of it looks like a pretty good income. It is about 75 percent higher than the average annual wage per employed factory worker in 1958.

But before we conclude from this that average net farm income for commercial family farms really was substantially higher than nonfarm income, we need to recognize that these net farm income figures include what is called the "charge for capital."[12] Deducting this charge for capital from the net income leaves the return to the operator and his family for their labor and management only. This is done for the years 1954 to 1958 in Table 1.

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[10] *Farm Costs and Returns: Commercial Family-Operated Farms by Type and Location,* ARS, USDA, Agr. Info. Bul. 176.

These farm cost and income data are not obtained by a survey of actual farms. They are synthetic figures, calculated by applying estimated changes in prices, yields, inputs, etc., to model type farms. They are estimates of the average costs and returns, not of all commercial family farms in each area, but of the type of farming specified in each area.

[11] This unweighted average is not as accurate an average as if the data were weighted by the numbers of farms in the different types. These numbers are not available at present. I believe that this lack of accuracy is small compared with that of the other averages discussed in the preceding sections. In any case, national averages do not mean much because of the great diversity behind the averages, as shown later in this paper. I use them here only because they are used so much in national policy discussion. My chief point is made later with the diverse area data.

[12] "This charge is the current value of land and buildings times the current interest rate on farm mortgages on this kind of property in the area plus estimated current value of working assets (machinery and equipment, livestock, and crops on hand January 1) times the interest rate on intermediate and short-term farm loans." (*Costs and Returns, Commercial Family-Operated Farms by Type and Size, 1930-1951,* Stat. Bul. No. 197, Nov. 1956, ARS, USDA, p. 7.)

"There are slight differences in our net farm income as presented in the various statistics on commercial farms and the net farm income released by AMS and given in figure 2, page 5, of AIB No. 176. Our farm series are based on owner-operated farms. Our net farm income therefore is the return to operator and family for their labor and management and for return on all capital or investment regardless of ownership. The net farm income used in figure 2 includes as expenditure interest on farm mortgage debt and net rent to non-farm landlords." (Letter from Wylie Goodsell, Assistant Chief of Costs, Income and Efficiency Research Branch, USDA, Dec. 17, 1959.)

The charge for land and buildings in the charge for capital was computed differently before 1954, so the returns to operator and family labor before that date are not comparable with the returns for the years after 1954.

Table 1. Net Returns to Operator and Family Labor, Commercial Family-Operated Farms by Type and Location, 1954–1958

Type and Location	1954	1955	1956	1957	1958
			Dollars		
Dairy farms:					
Central Northeast	2,551	2,984	2,758	2,887	2,844
Eastern Wisconsin	1,899	1,489	2,044	1,796	1,372
Western Wisconsin	1,493	1,553	2,033	2,040	1,997
Dairy-hog farms:					
Southeastern Minnesota	2,119	2,056	2,438	1,986	2,231
Corn Belt farms:					
Hog-dairy	4,729	2,689	3,345	3,991	5,061
Hog-beef raising	1,573	1,624	1,679	2,116	3,320
Hog-beef fattening	6,551	1,995	4,426	4,286	6,287
Cash grain	5,107	3,200	5,556	2,125	2,500
Poultry farms:					
New Jersey (egg-producing)	−3,529	606	−703	−565	−239
Cotton farms:					
Southern Piedmont	680	1,521	756	567	1,479
Texas:					
Black Prairie	756	1,501	−260	294	1,287
High Plains (non-irrigated)	2,912	929	880	4,222	6,542
High Plains (irrigated)	9,460	3,563	9,054	6,449	12,536
Mississippi Delta:					
Small	1,197	1,627	1,233	649	649
Large-scale	11,012	19,798	12,133	2,360	2,820
Peanut-cotton farms:					
Southern Coastal Plains	1,804	2,760	2,444	1,644	2,664
Tobacco farms:					
Kentucky tobacco-livestock	2,517	1,906	2,251	1,477	2,021
North Carolina:					
Tobacco-cotton	1,889	2,513	2,606	1,067	2,081
Tobacco-cotton (large)	1,419	2,580	3,034	618	2,145
Tobacco (small)	1,843	2,354	2,430	1,410	2,014
Spring wheat farms:					
Northern Plains:					
Wheat-small-grain-livestock	421	4,428	5,076	1,633	4,384
Wheat-corn-livestock	1,738	867	1,593	2,953	4,629
Wheat-roughage-livestock	1,244	2,678	1,190	2,339	2,702
Winter wheat farms:					
Southern Plains:					
Wheat	4,426	1,898	702	2,025	8,015
Wheat-grain-sorghum	261	−1,454	−715	1,415	7,373
Pacific Northwest:					
Wheat-pea	10,459	3,915	6,489	6,152	359
Wheat-fallow	—[a]	—[a]	—[a]	8,215	5,250
Cattle ranches:					
Northern Plains	979	95	−841	633	2,777
Intermountain Region	1,995	2,004	2,033	5,101	9,211
Southwest	−5,113	−2,174	−6,471	−1,701	2,068
Sheep ranches:					
Northern Plains	1,107	1,259	2,609	6,626	8,560
Southwest	−6,337	−3,821	−6,366	−3,004	1,530

[a] Information not available.
Source: Ag. Inf. Bul. 176, ARS, USDA.

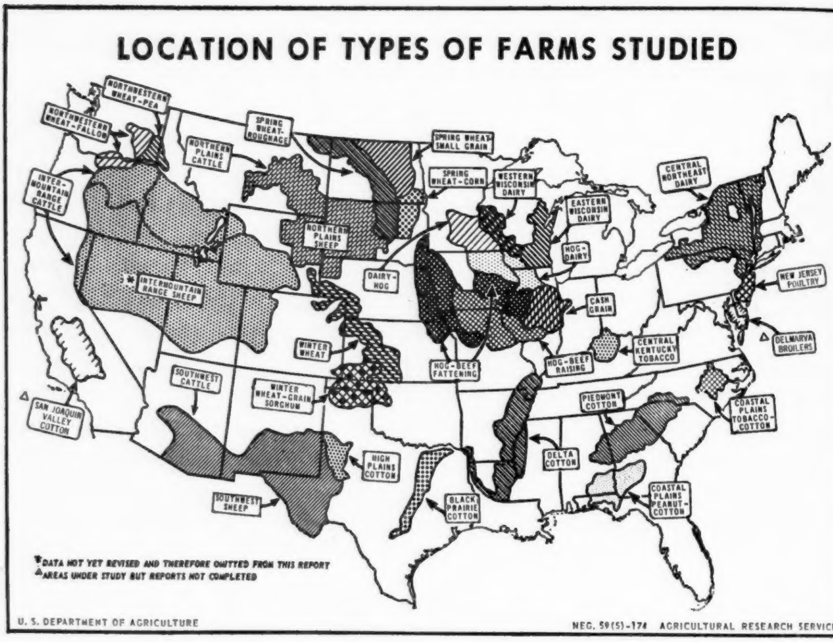

FIG. 1

These labor and management returns are roughly comparable in concept with the United States average farm income data shown above, but they show the average net income for regular *commercial family farms* in the areas shown in Figure 1, separately by types of farming in the different areas, rather than for all "farms" as defined in the Census, for the United States as a whole.

The labor and management returns are also more nearly comparable with the earnings of employed factory workers than the net farm income figures given above; they both show the returns to labor, not including a charge for capital in either case.[13]

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[13] The factory worker ordinarily would not have a "charge for capital" as such, but would have a return on his investments of his savings, comparable in some sense with a farm operator's return on his own savings invested in his farm.

The factory workers' earnings are not perfect for comparison with the labor and management returns to farm operators. The factory workers' earnings do not include returns to management as the farm returns series does. Also, factory workers are not strictly comparable with farm operators in some other respects. Ordinarily, they do not exercise much management; that is the prerogative of "the management." Furthermore, any income from other members of the family is not included in the factory workers' earnings, whereas they are included in the farm series if the other members of the family worked on the operator's farm, as they do in most cases. But the author does not know of any other authoritative series which is more nearly comparable with farmers' return for labor and management than the earnings of factory workers.

Significance of the Return to Operator and Family Labor Data

The simple United States average of the net farm incomes for the several types of commercial family farms in 1958 was $7,238. The United States average of the "returns to operator and family labor" after the charge for capital is deducted from the net farm income, shown in Table 1, was $3,702.

This $3,702 is about 24 percent higher than the United States average "farm" income from farming of $2,990 for 1958. Neither series is perfect for showing average farm income, but the data given in the table show more nearly what most people have in mind when they talk about farm policy.

Now I want to point out two things:

First, practically all the discussion about farm income is based on the U.S. average "farm" data which include all Census "farms" and yield the average farm income figure for 1958 of $2,990 just quoted. Not one man in a thousand who quotes these figures ever quotes these other more meaningful figures for commercial family farms ($3,702 for 1958) perhaps because in most cases he does not know that they even exist.

It would be illuminating if average farm income from nonfarm as well as farm sources could be compared with the incomes of similar small business entrepreneurs in other sectors of the economy. But the author does not know of any such nonfarm data.

Discussions of farm income policy, which usually means commercial family farm policy, will not be very accurate until they are based on commercial family farm income data.

My *second* point is of a different nature. It concerns the dispersion behind the U.S. average farm income data. Table 1 shows that there are wide differences among the average returns to operator and family labor in the different areas. In 1958 the average returns to operator and family labor ranged from $239 loss in New Jersey egg-producing poultry farms to $12,536 gain in the irrigated High Plains cotton farms in Texas.[14]

Furthermore, most of these differences persist over long periods of time, even in contiguous areas. There is great variation from year to year due to weather and other such causes, but by and large the incomes in most of the different areas stay in about the same relation to each other year after year. The high areas remain high and the low areas remain low.

Essence of the Farm Income Problem

Figure 2 shows these two essential points in graphic form. It shows the returns for two types of farming—hog-beef raising, and hog-beef

[14] The average net farm incomes in 1958, not shown in the table, ranged from $1,344 for the small cotton farms in the Mississippi Delta to $17,819 for the irrigated High Plains cotton farms of Texas.

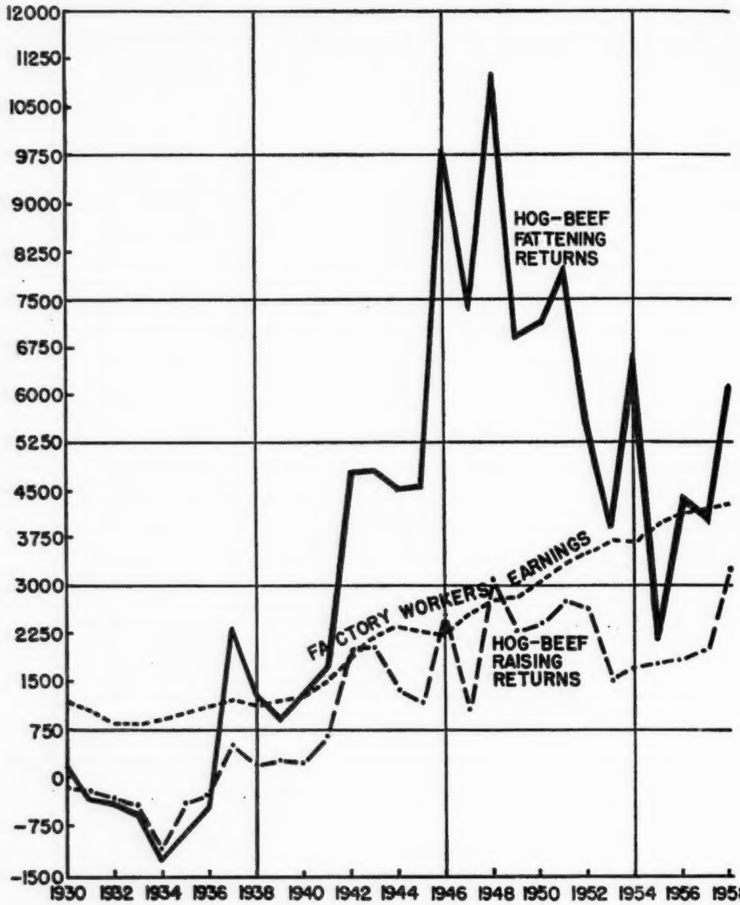

FIG. 2. HOG-BEEF RETURNS AND FACTORY WORKERS' EARNINGS, 1930-1958.

fattening—in two contiguous areas. The figure shows the net returns data for the two areas carried back to 1930, along with the earnings of manufacturing workers.

This figure illustrates the essence of the real farm problem in a nutshell. It shows that the problem is twofold.

First, income instability. The urban income series rises fairly steadily over most of the period. But the farm returns series jump all over the place—in the case of the hog-beef fattening series, from roughly 3 times as high as the urban series in 1948 to only half as high in 1955. The instability of the farm returns series stands out in marked contrast to the stability of the urban income series.

Second, income level. The chart shows also that the two farm series

differ greatly from each other. Year after year, the returns to operator and family labor are about twice as high in hog-beef fattening as they are in hog-beef raising.

This chart illustrates why a price program is an inappropriate way to deal with farm income problems. A price program to help hog-beef raisers just after World War II would have helped hog-beef fatteners too, at a time when their incomes were already several times as great as factory workers' earnings. Or to put it the other way around—hog-beef fatteners did not need a program in 1947 and 1954, for example, but hog-beef raisers did; their returns in those years were less than half as high as factory workers' incomes. What is needed is not price programs, which necessarily raise prices to all producers of the product alike, but income programs, by areas, for those types of farmers who need it.

And by income programs I do not mean direct income payments. Programs of that sort are like price programs in that they treat only the symptoms, and leave the basic disease, the maladjustment, untreated and in some cases aggravated.

In dealing with problems like these we could make much more use of the cost and income data that are already available—the original detailed data on which Table 1 is based. These data are published annually by the USDA.[15] They show, area by area, what the details of the costs and incomes for the different types of farming are, item by item. They show which costs have been increasing or decreasing, and give some indication why; which of the different sources of income have been increasing or decreasing; and so forth.

These are the kinds of data that a manufacturer would study if he had plants located in different parts of the country. He would study these data to find out which plants were unprofitable, and why, and what changes would be needed to make them profitable—conversion to other lines of production, expansion or contraction of scale, and so on.

Price policy alone would not solve this kind of problem; it might in fact make the disparity worse.

The inappropriateness of price programs as a solution for farm problems is shown also by a comparison of the returns to two kinds of cotton farms in the Mississippi Delta—small and large-scale. The return for the small farms in 1958 was $649; for the large-scale farms it was $2,820—more than 4 times greater. Even doubling the price support level for cotton would have brought the returns to the small farmers only half way up to the level attained by the large farms, which itself could hardly be considered excessive.

Furthermore, even production-control programs that succeeded in

[15] *Farm Costs and Returns: op. cit.*

raising prices by reducing acreage or changing the market structure probably would not increase net farm income in the long run if nothing were done to change the quantity or quality of the human factor, the farmer himself. Much of the gain probably would go to land, as it probably has over the past decade under the impact of new technology and the price-support programs. The average value of farm land and buildings per acre rose 68 percent from 1947-49 to 1959, but the average per capita farm income from farming actually declined 3 percent (from $665 to $643) over the same period.[16] There is every reason to expect that the same thing would happen in the future if most of the attention continues to be focussed on programs for farm product prices and very little on programs for farm incomes.

The coal miners under John L. Lewis did not concentrate on programs to raise the price of coal in the hope that this would benefit coal miners; they concentrated on reducing the supply of miners and getting their incomes up. Farmers might well ponder that this has implications for their programs.

Several Conclusions

Several conclusions, then, begin to emerge:

1. The low farm income problem is not "a" problem, affecting all areas alike. Farm incomes in some areas are very low; in some other areas, they are higher than factory workers' incomes. The problems differ from area to area, and different solutions are needed in different areas.

2. We need to do more research to determine why incomes in some areas are persistently low. It is not a matter of poor soil or weather; some of the poorest soil and weather is to be found in the Intermountain region, where the average farm income is among the highest in the country. It probably is a matter of sub-optimum farm organization and adjustment.

3. Farm policy needs to be reoriented—if not away from price programs to farmer income programs, at least to give major attention to farmer income programs as well as price programs.

The programs should be directed, not to supporting prices and creating huge surpluses, nor even solely toward reducing the supplies of farm products and increasing the demand for farm products, but also to specific action that will benefit farmer incomes.

This involves research to determine in each area whether farm incomes are low there because there are just too many farmers, or whether incomes are low because farms are not of the size and organization that can benefit most fully from recent technological advances. If the former, then programs are needed to help surplus farmers off farms into better urban jobs; if the latter, then programs are needed of a farm adjustment

[16] *The Farm Income Situation,* USDA, Feb. 1960, p. 32.

sort, focussed upon the areas that need it most, and differing from area to area as may be needed to fit the different situations in the different areas.

What is needed is a group of separate but related income and cost programs, area by area. These programs need to deal separately with the particular net income or return-to-family-labor problems in each area –and to deal with them not merely by raising prices or bolstering income as such, leaving the underlying causes of low income unchanged, but by dealing with the underlying causes.

These programs would need to include programs to deal directly with the human factor as well as with the farm products; otherwise they could not by themselves solve low farm income problems which result from a continuous over-supply of farmers as well as farm products. The birth-rate in agriculture is higher than necessary, so that about 85 percent of the farm boys and girls now growing up on on farms will need to take jobs in town when they grow up.[17] Surplus farmers depress incomes per farmer just as surplus farm products depress prices per unit of product. Excess farm boys and girls need schooling and training for urban jobs, and facilities for this purpose are inadequate in many farm areas. Programs to deal with these training needs and help farm boys and girls to get in touch with urban jobs illustrate what we mean when we call for programs to deal with basic causes rather than with symptoms. Economic and sociological community problems would also need to be considered–the effects on schools, stores, churches, and so forth.

These things require more research and program development, in many cases of a different character from what has been done before. Those who prepare the basic income statistics, for example, are laboring with inadequate funds to do the job in enough detail and as thoroughly as they know how to do it and would like to do it. More research is needed all along the line to help farmers not merely to increase production and marketing efficiency, but also to adjust to the results of this efficiency so as to benefit rather than be harmed by it. Some research of this character is already being done to point the way; what is needed is to work out more detailed maps and directions, and develop programs to deal with the problems revealed–different programs adapted to the different problems in the different areas.

These programs could be developed with the help of a series of separate conferences in each region. These conferences could include research men from the USDA and the state universities in the region, in their role

[17] Shoemaker, Karl, *Opportunities and Limitations for Employment of Farm People Within and Outside of Farming*, Federal Extension Service, USDA, Mimeo., June 1958, p. 4.

as research scientists; the organized farm groups in the region—Farm Bureau, Grange, Farmers Union, etc.; the commodity groups involved, such as the Milk Producers' Federation and the Great Plains Wheat Market Development Association, which includes state university research men in some of its conferences; farmers and business men in the region; and consumers. If the views of these conference members were divergent, the conferences would be a good means for resolving them.

The state universities could well take the initiative in calling these conferences, as part of their agricultural adjustment research and extension activities.

The conferences could be expected to develop programs, to be coordinated with programs from other regions; or if more research is needed before such programs could be worked out the conferences could outline the needed research areas and arrange for getting the research done.

Summary

The freshness of the approach to farm policy taken in this paper consists (1) in looking at incomes to farmers, by areas, rather than simply at prices by commodities, (2) in suggesting research on programs, area by area, to cure the causes of the low incomes rather than alleviate the symptoms, and (3) in directing more attention to the human factor, the farmer himself.

THE ROLE OF PROBLEM RECOGNITION IN MANAGERIAL ADJUSTMENTS*

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THE objective of this paper is to focus attention upon the nature of problem recognition relative to managerial adjustments and to express some implications of problem recognition to educational efforts in farm management. In accomplishing this objective, the procedure will be to explore the treatment of contemporary writings on the problem recognition facet of managerial adjustment, to express some observations on the role of problem recognition both conceptually and as observed under Alabama conditions, and to advance some interpretations of these observations relevant to efforts to help individual families increase their incomes.

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* Adapted from the unpublished M.S. thesis by John E. Lee, Jr., *An Empirical Study of the Problem Recognition Step in Managerial Adjustment,* Alabama Polytechnic Institute, 1958. See this reference for significance tests and other details which are omitted here in the interest of brevity.

Attachment of great importance to problem recognition in reflective thought is not new.[1] Problem recognition in educational and research efforts, in general, is well appreciated.[2] The treatment of problem recognition in the framework for making decisions and adjustments on a deliberate basis in farm management is disturbing. Prominent among such treatments are the works of Professor Glenn L. Johnson and associates. In these works the assumption is made that the problem is recognized or problem recognition is ignored.[3] Johnson's listings of the observation, analysis, decision-making, action-taking, and responsibility-acceptance steps in management need to be preceded by the identification of problem recognition as a specific step.

A clearly defined problem is one of the prerequisites for sound thinking and reasoning.[4] It is necessary before the problem-solving process can be successfully employed. A clear definition of the problem is essential if managers are to attach meaning to the adjustment concept. Problem recognition is the key to adjustment and warrants consideration not merely as a point from which to proceed, but rather as a definite phase in the adjustment framework.

Difficulties arise from risks and uncertainties created by change. Although the difficulties may be felt by the manager, they, at the same time, may be vague and difficult to identify as a problem. The following steps are offered as a meaningful, organized process of defining problems from felt difficulties: (1) *A difficulty is felt.* A felt difficulty may appear as a perplexity, a bafflement, or a need for which established habits and ready knowledge offer no satisfactory escape or means of adjustment.[5] (2) *Knowledge and information relative to the felt difficulty is gathered, organized, and observed.* (3) *Alternative definitions of the problem are recognized.* Knowledge, reference groups, and other forces influence the ability of the individual to recognize alternative definitions of the problem. (4) *Alternative definitions are analyzed in the light of information observed.* (5) *The problem is defined, a decision is made or a definition*

[1] For two such viewpoints see: John Dewey, *How We Think,* D. C. Heath and Co. 1933; T. L. Kelly, "The Scientific Versus the Philosophic Approach to the Novel Problem," *Science,* Vol. LXXI, 1930.

[2] J. Carroll Bottum, "Increasing Farmers' Understanding of Public Problems and Policies," *J. Farm Econ.* 37:1307, Dec. 1955. Joseph Ackerman, "The Theory of Research in Farm Management," North Central Farm Management Research Workshop, 1949. American Marketing Association, *The Technique of Marketing Research,* New York: McGraw-Hill Book Co., Inc., 1937.

[3] Glenn L. Johnson and Cecil B. Haver, *Decision-Making Principles in Farm Management,* Ky. Agr. Exp. Sta., Bul. 593, 1953. Glenn L. Johnson, *Managerial Concepts for Agriculturalists,* Ky. Agr. Exp. Sta., Bul. 619, 1954.

[4] Joseph Tiffin, Frederic B. Knight, and Eston J. Asher, *The Psychology of Normal People,* Boston: D. C. Heath and Co., 1946, p. 490.

[5] Howard L. Kingsley, *The Nature and Conditions of Learning,* New York: Prentice-Hall Co., 1946, p. 372.

decided upon. (6) *Responsibility for problem definition is accepted.* The person who makes the decision as to the definition of the problem should be prepared to accept the consequence of his choice. Failure to size up the situation carefully and to analyze all the significant facets is likely to lead to disastrous results or an unsuccessful attempt at adjustment. Correct solutions to the wrong problems may result in unsatisfactory adjustment.

A summary of an adjustment framework identifying the suggested role of problem recognition relative to the steps included in the deliberate forms of behavior is portrayed diagramatically in Figure 1. The consecutive steps in the adjustment process, beginning with change which necessitates the adjustment, constitute the core of the diagram. In this diagram, the problem recognition step is placed in perspective relative to the steps or tasks earlier listed by Johnson and associates.[6] Recognition is also given to action that is not directed by deliberate decision-making processes.[7]

Recognition of Opportunities and Problems by Alabama Farmers

The preceding discussion of adjustment suggests that recognition by farmers of the problems confronting them is an important step in successful adjustment to changes. To test this hypothesis, empirical data were obtained from a population that consisted of farm families participating in intensive Farm and Home Development activities in Alabama.

Farm and Home Development (FHD) refers to special endeavors of the United States Department of Agriculture and the cooperating State Extension Services to stimulate better farming and better living through better management of the farm and home as a unit. FHD activities center on intensive assistance to individual farm families in using a systematic problem-solving procedure to attain their own goals that bring an enriched and more satisfying life.[8]

The sample described

In 1957, two full years after FHD was begun, data were collected from a sample of FHD agents and farm families for a study of managerial adjustments in Alabama. In each of eight farming areas of Alabama,[9] two

[6] See Johnson, *Managerial Concepts for Agriculturists, op. cit.*, for details regarding other adjustment steps not discussed in detail herein.

[7] Cf. B. D. Crossman, "Discussion: New Knowledge of Decision-Making Processes," *J. Farm Econ.* 40:1406, Dec. 1958.

[8] Ben T. Lanham, Jr., et al., *The Role of Farm Management Research Workers in Initiating and Executing A Farm and Home Development Program On A State Basis*, Southern Regional Farm Management Research Committee Report, Jan. 1955.

[9] Ben T. Lanham, Jr., et al., *Alabama Agriculture—Its Characteristics and Farming Areas*, Ala. Agr. Exp. Sta., Bul. 286, May 1953, p. 3.

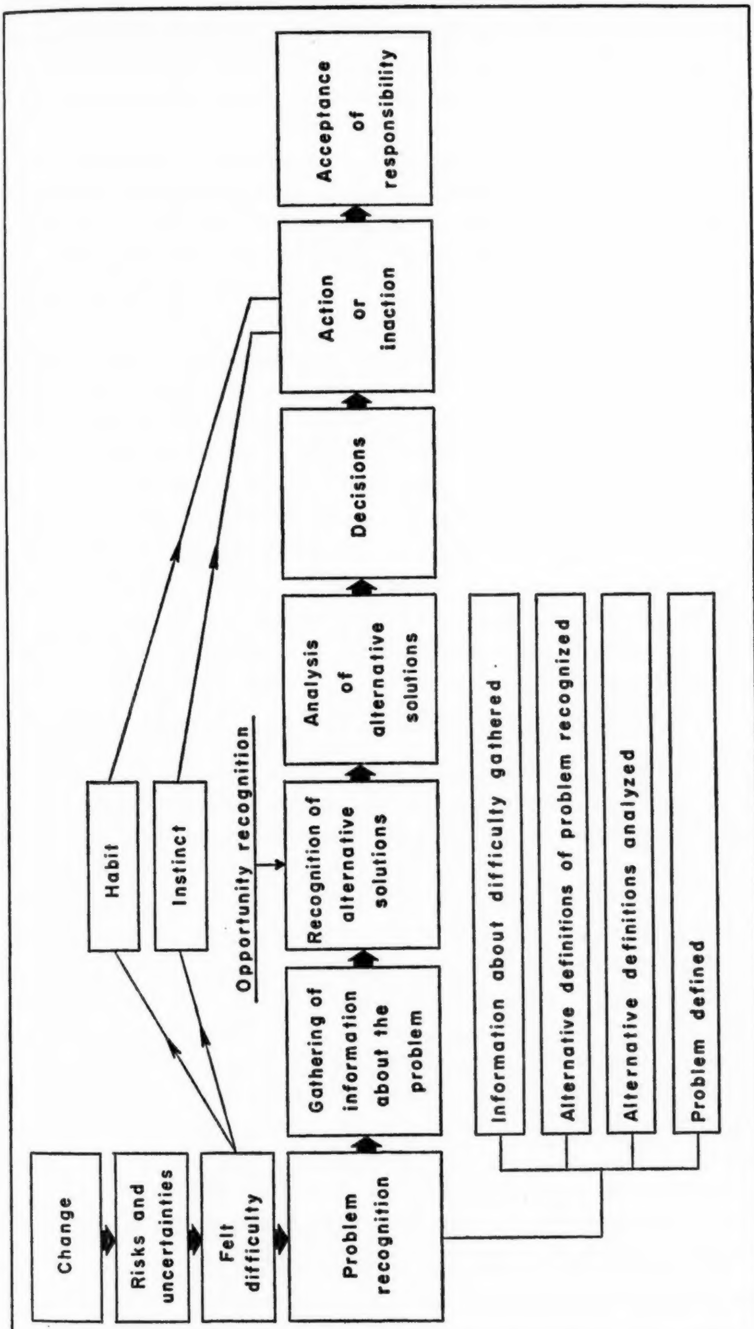

FIG. 1. CONCEPTUAL PORTRAYAL OF MANAGERIAL ADJUSTMENT

counties were selected at random from those that had active FHD programs. Within each two-county segment, 32 participating families who had 1955 and 1956 farm business records on file in the State Extension Office were selected by a random method. Data from 252 usable family interviews were recorded.

Primary data for the study were obtained by trained enumerators using questionnaires designed to reveal information regarding the adjustment opportunities and experiences of farm families and the nature of the thought processes involved. Farm business records relating to the progress of individual families included in the sample were made available by the Extension Service.

Many types and sizes of family farm operations were represented in the sample. FHD activities in Alabama are not restricted to any particular type or size family farm operation. The age of the farmers ranged from 26 to 72 years with the average being 47 years; their average education was 9.9 years, with some having as little as 3 years of formal training and some having done graduate study. Fifty-one per cent of the farmers interviewed had received no formal training in agriculture. Over half the families had off-farm income. The farm business volume as measured by productive man work units ranged from a low of 82 to a high of 3,711 days with an average number of productive man work units per farm of 512 days.

Some Empirical Observations Summarized

Wide variations in volume of business, labor efficiency, rates of production, and income among families and farms included in the sample indicated the existence of problems in the operation of these farm businesses. On many farms, volumes of business were too low for efficient operation and utilization of resources: 30 per cent of the farms producing cotton had less than 10 acres in cotton; about 30 per cent of the commercial dairy farms had fewer than 10 dairy cows and 70 per cent had less than 30 dairy cows; and 70 per cent of the farms producing beef had fewer than 30 beef cows. Labor efficiency as measured by productive man work units per man equivalent was low on approximately 70 per cent of the farms. Ten per cent of the farms in the sample producing milk on a commercial basis averaged only 2,532 pounds of milk per cow, and 10 per cent of those farmers selling eggs averaged only 97 eggs per hen per year; these figures illustrate that rates of production were often below the break-even point. Half of the farm operators in the sample had negative labor income, and more than half had negative return on capital.

Income opportunities visualized

Even with such problems evidenced, over 40 per cent of the respondents said they saw no way to increase income on their farms at prevail-

ing prices. Nearly half of the farmers failed to recognize greater income opportunities. This indicated that they believed their farms were already being operated in the most profitable manner possible. Yet the farm business summaries usually revealed basic weaknesses in the operation and/or organization of those farms whose owners saw no way of increasing income. That these managers could in no way identify means of improving their farm businesses is indicative that they were unable to recognize basic problems from which such opportunities emanate.

The proportion of managers recognizing income opportunities decreased as age of managers increased and increased as number of years of formal education increased. No meaningful relationships were found to exist between awareness of opportunities for higher income and managers' farm background or number of dependents. There was, however, some evidence that as the stage in the family cycle progressed, the percentage of managers who said they could make more money on their farms without price changes decreased. The proportion of farmers in the sample who said they could make more money was lowest for those with a net worth of less than $10,000 and increased as net worth went up in $10,000 intervals.

Problems identified

Those respondents who identified specific problems as being of major importance often left reason for the belief that the problems they recognized were superficial, i.e., only a part of larger or more basic maladjustments. For instance, 19 per cent of the respondents said in almost these words, "Prices paid high and prices received low and ends don't meet." If these farmers realized that the big problem or difficulty behind this was one of adjusting management to changing price or other conditions they did not so indicate.

Analysis of data in farm business summaries indicated that 74 per cent of those farmers who said their major problem was a shortage of labor were inefficiently utilizing labor they had. Many farmers indicated lack of capital as their main problem, but further questioning of a "back door" nature indicated they were unwilling to assume the risk of borrowing money. Of the farmers who said they did not have enough land for sufficient income or to expand operations, 62 per cent were engaged in production of an extensive rather than intensive nature.

Other opportunities and problems visualized

Price outlook. An indirect approach taken to determine the farmers' awareness of problems was to ascertain whether they recognized opportunities resulting from those problems. Many respondents were unaware of the opportunities for using knowledge of changes in prices of resources

and products or of price outlook. Fourteen per cent of the respondents did not keep up with price information, and 34 per cent indicated they kept up with price information only on the commodities they produced. The most often mentioned use made of price information was for marketing purposes. Fewer than 8 per cent of the farmers said they used price and price outlook information in planning enterprise sizes and combinations. More than 22 per cent of the managers who kept up with prices did not indicate making any use of that information.

Some of the farm managers insisted it was useless for them to keep up with current or expected price changes. Three per cent of the respondents said the government controlled the prices of the products they sold, or that their crops or livestock products had to be sold when in prime condition or when harvested regardless of price.

The percentage of farmers who made use of price information increased as age of the farmers decreased, as number of years of formal education increased, as number of years of off-farm experience increased, and as size (acres open land) of farm increased. No significant relationship existed between use made of price information and stage in the family cycle or net worth of families.

Credit. Of the 252 respondents, 185 used credit during the year prior to the survey. Current operating loans for periods of one year or less were used by 80 per cent of the respondents using credit. About 27 per cent used intermediate type credit and 21 per cent borrowed money for long-time investments.

Farmers appeared more willing to borrow money on a short-time basis. To obtain long-term loans meant committing themselves to having something "hanging over their heads" for a long period of time until that "thing" could be "paid off." The thinking of some farmers was aligned with economic tradition and traditional reference groups so as to give a morally "bad" connotation to the idea of owing money. There was evidence that such thinking was an unrecognized problem within itself and tended to blind farmers to opportunities afforded by the use of credit. Unwillingness to assume the risks of credit, especially intermediate or long-term credit, may have denoted lack of appreciation of opportunities for strengthening the capital resources of farm businesses.

Neither age, formal education, farm background, source of family income, nor stage in the family cycle was found to be significantly related to the percentage of farmers who borrowed money for current operations. However, the percentage of farmers who used credit for longer periods of time increased as age decreased, as educational level increased, and as off-farm experience of managers increased.

Off-farm employment. Farmers who recognize off-farm employment

opportunities have an additional alternative solution to their income problems. Sixty-one per cent of the respondents recognized no opportunity for off-farm employment that would afford them as high or a higher standard of living than they were making on the farm. (Of those managers who thought that getting off-farm jobs presented no difficulty 42 per cent already had such jobs.) Most of the managers listed age or lack of necessary training or a combination of the two as reasons they would find difficulty in getting off-farm work.

Difficulty recognized in getting off-farm employment decreased significantly as age decreased, as years of formal education increased, and as off-farm background increased. In addition, fewer of those farmers who had had some formal agricultural training recognized difficulty in getting a job off the farm.

Plans and records. Farmers who fail to make plans or who do not keep accurate records for use in decision making may overlook opportunities for increasing income. Only 30 per cent of the farmers in the sample made long-time organization plans, 15 per cent had short-time plans and 70 per cent kept records that they analyzed for aid in decision making. The percentage of farmers who made both types of plans and who kept records increased as age decreased, as level of education increased, and as proportion of life spent on the farm decreased. Neither stage in the family cycle nor net worth of farmers was found to be closely related to whether farmers kept records or made plans.

One respondent's thought-provoking comment is evidence that he was aware of a very real problem. He stated that he grew up on a small subsistence type farm and that his greatest problem lay in the difficulty to adjust mentally from subsistence thinking to the thinking required in the high-risk environment of present-day commercial agriculture. He recognized the retarding forces that make it hard to break away from established patterns of economic thought.

Implications of the Study

Management is difficult! Profitable management requires successful adjustment to change. Identification of the problems that evolve from change facilitates satisfactory adjustments. Changes in agriculture and in the general economic environment are expected to occur at least as fast in the future as in the past. As these changes occur, greater risks and uncertainties will be characteristic and adjustment requirements will be more exacting. Inability to recognize the problems created by these changes will continue to preclude or retard satisfactory adjustment.

Characteristics of older farmers revealed by the study may indicate difficulty in the implementation of public programs designed to help low-

income farmers. Census data reveal that the average age of farm operators in Alabama increased from 43 years in 1930 to 50 years in 1954. This trend is typical for the country generally. Comparatively few men are entering farming and many young and middle age farmers are leaving the farm to seek employment in related or other fields. Older farmers are the ones who are the most immobile. Since younger farmers, in general, recognize opportunities for greater income either on or off the farm, older farmers are the ones who need help.

Government programs such as the Soil Bank are not as effective with older farmers as with younger farmers. Younger farmers can put their land in the conservation reserve, get an off-farm job, and receive income from two sources. Older farmers have more difficulty getting other work. Thus, if government payments are not equivalent to the income received from farming, older farmers do not benefit from such programs. The only alternative remaining for older farmers other than direct income payments is to do a better job of farming. However, they are the farmers most reluctant to keep records, make plans, borrow money, keep up with price information, and make other changes required to increase income. The problem of older farmers makes and will continue to make difficult the tasks of both policy makers and of those associated with the implementation of resulting programs.

That farmers with little or no farm background do a good job of farming and recognize more ways of increasing income may foretell the movement of capital into agriculture from sources not previously interested in farming itself. Non-farm capital owners who recognize ways to profitably employ their capital in farming may become a new source of competition to the lifetime farmers and exert great influence on methods of farming in the future. Furthermore, since management tends to be closely tied to the "purse strings," farm management may be shifted out of the hands of farm people and into the hands of "money owners." Evidence that this implication is realistic is the recent movement of non-farm capital into contract farming by capital owners seeing opportunity for economic gain as contractors.

Apprehension of credit risks revealed in the findings of this study imply that more and more farmers will move to off-farm work and become part-time farmers. High capital requirements of modern farming are causing, and will continue to cause, those farmers unwilling to accept the risks of credit to seek off-farm income to get the capital needed by the farm operation, or to accept some scheme for the transfer of risks to others and to secure capital. Once farmers become accustomed to working on a salary basis and once, as a result of salaries, they establish periodic financial commitments for such things as appliances, home im-

provements, and automobiles, it is improbable that they will return to farming as a sole source of income. Thus, apprehension of credit risks may increase mobility as far as the shift to more part-time and residential farming is concerned.

Public institutions, if they are to be of service to farm people, must first familiarize themselves with the principles of problem recognition. Researchers and educators must redirect their efforts toward helping farm families as well as farm managers to better understand the significance of changes that have occurred and are occurring and the opportunities and requirements associated with those changes.

The findings of this study focus attention upon the changes that are happening and will continue to happen in the agriculture of the region. Tremendous changes—seeemingly daring changes—will need to be made by agencies and organizations supporting agriculture if adequate human and non-human resource adjustments are to be achieved.

DEMONSTRATION EFFECTS ON PRODUCTION

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A CENTRAL theme of Galbraith's *Affluent Society*[1] is that, given the income levels and economic philosophy (conventional wisdom) current in this country, reasonably full employment of the Nation's resources requires production of private wants as well as the goods to satisfy such wants. The theme continues to the effect that "want production" is being accomplished variously through urging upon consumers the merits of more and newer gadgets, installment buying, etc., and the urge of individuals to "keep up with the Joneses." A major objective of Galbraith's book was to criticize the philosophy which causes national affluence to be dissipated in private frivolity while public needs go unmet.

Earlier, Duesenberry discussed the dependence of one person's consumption demand upon the consumption behavior of others, especially the behavior of close associates. His term for this interdependence of consumption behavior was "demonstration effect."[2]

Both writers were concerned with the demand side of economic behavior—the influence of the consumption activities of one person or group upon the consumption desires of another person or group.

[1] J. K. Galbraith, *The Affluent Society*, Boston: Houghton Mifflin Company, 1958.
[2] J. S. Duesenberry, *Income, Savings and the Theory of Consumer Behavior*, Cambridge: The Harvard University Press, 1952.

Demonstration Effects on Production

The purpose of this note is to suggest that "demonstration effects" might also be observed on the production side of economic behavior. That is to say, the income levels of one's close associates may well determine the extent to which he is motivated to undertake the additional toil, risk, and uncertainty associated with earning a "high" income rather than only a "moderate" one. Further, it is to suggest that demonstration effects may become operative long before a people achieve much affluence.

Among urban workers it would be difficult to observe demonstration effects on their income-earning activities, as work hours and wages tend to be established on a group rather than individual basis. Such workers have only limited freedom to adjust their incomes to their individual desires for work, consumption, and savings.

In occupations such as farming, where self-employment is the rule, marginal adjustments are more feasible. Hence, by examining income variations and certain other things among the self-employed one might determine the presence or absence of demonstration effects.

Economic Phenomena in Certain Low-Income Farming Communities

Three sets of data, two of which have been published,[3] have suggested this note. All three concern inter-family income variations in relatively isolated, low income southern farm communities. All three sets of data appear to exhibit inverse net associations, within each low income community, between variations in farm real estate investments and family incomes. More cautiously, one should say that they indicate an absence of associations between the two variables, as the net regression coefficients were small and the probabilities of the regressions having resulted from chance in sampling were high. Because real estate investments were positively correlated with family wealth in two of the sets,[4] the lack of net positive association between real estate investments and income seems to reflect "inefficient" resource utilization by the more well-to-do families, i.e., utilization patterns that favor leisure at the sacrifice of income.

These relationships suggest that motivations were for a more complex objective than simply income maximization. Such behavior patterns are, at least, compatible with the hypothesis that income motivations tend to be limited by the income levels of one's close associates, i.e., by what is required to "keep up with the Joneses."[5] Of course, it is not clear whether

[3] Glenn L. Johnson, *Sources of Incomes on Upland Marshall County Farms*, Progress Rept. 1, Kentucky Agr. Expt. Sta., Univ. of Kentucky, Lexington, June 1952; and R. B. Hughes, Jr., "Marginal Returns on Agricultural Resources in a Southern Mountain Valley," *J. Farm Econ.*, May 1954.

[4] One cannot determine from Johnson's article whether the same was true in his Marshall County data.

[5] Also with the hypothesis that land is prized as a consumption item (a consumer durable), or for security, not only as a production resource.

the important "Joneses" were those with whom these people associated in the past (during their formative years of childhood) or whether they were those persons with whom they were currently associated. In either case, their associates were very poor, relative to national "standards." Hence, only a small income was required to keep up.

Analysis of the Third Set of Data

This note presents an analysis of data concerning 51 farm families, selected at random from families living on the Southern Highland Rim Area of Lincoln County, Tennessee in the Spring of 1951.

Among these 51 families, as was previously reported for Greene County familes,[6] the marginal earnings on investment tended to diminish to near zero long before farming operations were of a scale that would "fully" utilize family labor forces. In fact, utilization of family labor may have been inversely related to the ownership of the land.

The following equation was secured by the least-squares method:

$$\hat{Y} = 99.8 X_1^{0.271} X_2^{-0.053} X_3^{0.114} X_4^{0.232}$$

Where:

$\hat{Y}$ = Gross income (including perquisites) plus inventory changes (including depreciation) minus cash expenditures
X_1 = Man-month-equivalents of family labor
X_2 = Family equity in real estate
X_3 = Family equity in livestock
X_4 = Family equity in power sources and equipment[7]

From the equation one can calculate \$337 as the net difference in income associated with twice-average investments, rather than average investments, in each of the three categories (real estate, livestock, and machinery). In other words, when eliminating the influence of variations in the size of the family labor force, families with twice-average equities in each of the three resource classes earned around \$337 more than did families with average equities.

Small though it is, the \$337 exaggerates the net association that existed between equity levels and incomes. At higher equity (wealth) levels there was a tendency for a greater proportion of family wealth to be invested in land, while the proportions invested in livestock and machines declined. As already indicated, the net regression of family investments in

[6] Hughes, *op. cit.*

[7] Average quantities were $\overline{Y} = \$1{,}496$, $\overline{X}_1 = 16.12$, $\overline{X}_2 = \$5{,}008$, $\overline{X}_3 = \$901$ and $\overline{X}_4 = \$1{,}127$. $R^2_{y.1234} = 0.368$. The t values (for hypotheses of no regression) and probability levels (of the regressions having resulted from chance in sampling) were: $t_1 = 1.196$, $0.3 > P > 0.2$; $t_2 = 1.195$, $0.3 > P > 0.2$; $t_3 = 0.746$, $0.5 > P > 0.4$; $t_4 = 2.735$, $0.02 > P > 0.01$.
The regression constant, 99.8, was computed so as to cause the equation to pass through the averages, $\overline{Y}$, $\overline{X}_1$, $\overline{X}_2$, $\overline{X}_3$, $\overline{X}_4$. This does not materially influence the estimates for which the equation has been used.

real estate upon family income was slightly negative ($b_{y2.134} = -0.053$). Thus, the actual increase that was associated with a doubling of the equity level was less than \$337.

An additional equation was fitted to these data in which (1) family equities in real estate, livestock, and power units and machines were lumped together into one category and (2) an age variable was entered.[8] The least- squares equation is as follows:

$$\hat{Y} = 92.03\, X_1^{0.8071}\, X_5^{0.1502}\, X_6^{-0.2227}$$

where $\hat{Y}$ and X_1 are the same as in the previous equation, while

$X_5 = X_2 + X_3 + X_4$, i.e., total family wealth
$X_6 = 80$ minus age of the farm operator[9]

This equation indicates only a slight positive regression of income on family equity in the above-average (\$7,036) equity ranges.

Using this equation, one can estimate \$164 as the net difference in income associated with a twice-average, rather than average, equity level (allowing the composition of equities to vary as it did in the sample). Thus, the net increase in income that was associated with a twice-average equity level was nearer to \$164 than to \$337 (the estimate obtained with the first equation). Further, the scatter of the data about the upper end of the function is so great that it is risky to say more than that there was some slight tendency for above-average equity levels to have a positive net association with above-average incomes.

Judging from actual farming operations observed, the following opportunities seemed to be associated with different amounts of family wealth:

(1) With no wealth, families had no alternative except to leave agriculture or remain as share croppers or hired farm laborers.

(2) With a few hundred dollars, families could furnish their own tools and work animals. By doing so they could rent land on a more favorable share rate. However, the land area they could handle with workstock was too small to permit more than modest incomes.

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[8] Variations in (1) the composition of investments and (2) the family wealth levels were correlated with (3) the farm operator's age. This suggested that age, or an associated decline in ability, might cause the lack of relationship between equity levels and incomes.

[9] Average quantities were as follows: $\overline{Y} = \$1,496$, $\overline{X_1} = 16.12$, $\overline{X_5} = \$7,036$, $\overline{X_6} = 34.1$. $R_y^2{}_{.156} = 0.1801$. The t values (for hypotheses of no regression) and probability levels (of regressions having resulted from chance in sampling) were: $t_1 = 2.4825$, $0.02 > P > 0.01$; $t_5 = 1.6058$, $0.2 > P > 0.1$; $t_6 = 0.6495$, $P > 0.5$.
The regression constant, 92.03, was computed so as to cause the equation to pass through the averages, $\overline{Y}$, $\overline{X_1}$, $\overline{X_5}$, $\overline{X_6}$. This does not materially influence the estimates for which the equation was used.

(3) With somewhat more wealth, families could acquire a tractor and machinery. With a tractor a family could rent and farm enough land to provide income equal to or above the community average. As an alternative they could become owner-operators on small farms with mortgages. As owner-operators on small farms they would have incomes only slightly larger than the incomes of tenants furnishing their own tools and workstock.

(4) The more wealthy families of the area could earn well above average incomes operating larger-than-average farms with tractor power. As an alternative they could earn average incomes by operating larger-than-average farms with renters or hired labor.

The statistics of the two equations indicate that among the more wealthy families choices were more often in favor of overseeing renters or hired laborers rather than in favor of mechanization.

If one seeks to explain these relationships in terms of human motivation, it seems reasonable to argue that there was an urge to avoid personal effort and risk in excess of that required for earning average incomes.[10] In such circumstances creation of private wants for non-frivolous things, e.g., education and medical care, might be one of the more effective means of inducing the adjustments that are required if the people (or their children) are ever to become affluent.

[10] The ideal of membership in the class of landed aristocrats, who oversee rather than toil and sweat, may still be a major goal of these people.

Other explanations of these phenomena have been suggested. To the writer, none of them seem more tenable than the one advanced above. For instance, some have said that Lincoln County farmers were ignorant of the income potential involved in tractor mechanization and that, due to inexperience, they were incompetent to use and maintain tractors. Neither suggesion seems reasonable. To begin, the economic feasibility of mechanization had been well demonstrated by several families in the area. Secondly, all of the families with sufficient means to acquire tractors were demonstrating adequate mechanical abilities by operating and maintaining motor vehicles.

RISE AND DECLINE OF A CASH CROP IN AN INDIAN VILLAGE

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DURING the second world war, in spite of an increase in food prices, peasants of the village of Ranawaton-ki-Sadri, 36 miles to the east of the capital of the princely state of Mewar, India, adopted cultivation of tobacco as a cash crop and learnt the new method of cultivation. Waste lands, single-cropped plots and, later, irrigated plots were converted into

tobacco fields. Ten years later two increments in taxation were withstood well by the villagers, but the third increase, in 1955, had the sudden effect of throwing most of the small-scale cultivators off the margin of cultivation. A few larger farmers enjoying a goodwill in the local market for their produce continued the growth of an improved variety of tobacco, the medium group of cultivators reverted to the old cash crop of cotton, and those at the lower levels to the food crop, maize. The extent of influence of taxation policy on a cash crop grown in a village in a tradition-bound agricultural society, adjustments and readjustments necessitated by the rise and decline, and the differential impacts on various groups in a caste-structured society are examined in this paper.

The Background

Prior to 1939, village land was used for three purposes: (a) pastures (b) single-cropped land for growing maize and (c) double-cropped land for producing wheat with grams in the second season. The cultivators could be classified into three groups—high, medium, and the low. Roughly, their economic status was reflected in the social and ritual position of their castes. The higher group consisted of landlords and their kinsmen; they mostly acted as senior partners in joint cultivation, without themselves engaging in actual cultivation. The medium group was engaged wholly in agriculture, took pride in this profession, and considered education and business as irrelevant. The lower group depended upon the higher groups for employment as partner-cultivators or as farm servants, and at times succeeded in having small plots for their own use. This group took to agriculture from necessity and lived on a subsistence level.

Politically, the village remained a part of the princely state of Mewar till 1947. After that the state merged with the Indian Union and became subject to the Central taxes.

The village had previously grown cotton as a cash crop, but tobacco was introduced into the region for the first time in 1939.

A businessman from Gujerat, then a part of the British Indian Province of Bombay, used to come to the region for trade. Having suffered a sudden loss, he tried to rehabilitate himself near the village under study. He cultivated tobacco and, after two initial failures, reaped a bumper crop in 1941. This attracted notice of one of the members of the higher caste who joined hands with this expert to start cultivation on a commercial scale. The partnership of the visiting experts and local peasants became almost contagious, and cultivation began to spread. In later stages, as the local cultivators got used to the technique of raising the new crop, the partners of the initial stage became independent cultivators. Lower castes grew the seed even in backyards of houses, and the medium castes

shifted single-cropped areas to the new crop. The higher castes transferred even some of the double-cropped areas to tobacco. Increased incomes were obtained, since growing of tobacco was tax-free in the princely state whereas the price in the market included the Central tax in the British Indian Provinces. Commercial calculations warranted an increase in this cash crop. The peasants continued to get good profits until independence. Old debts were wiped off, new houses were built, wells dug or improved, and two persons in the higher group even purchased tractors.

After 1947 taxes were levied, and in two installments they were raised to an equivalent of 7 cents per pound. Up to this limit the taxes were tolerated. People had seen the success of the new experiment and were willing to pay the excise duty. It appeared that the new experiment had succeeded to the point of becoming a permanent feature of the village economy.

The Decline

The success came to a sudden halt in 1954-55. The number of growers decreased from 48 to 20 within the year, and production fell from 64,000 lbs. to 36,000 lbs. This sudden decrease of nearly 60 percent in the number of cultivators and 45 percent in production within one year followed as a consequence of increasing the tax rate nearly threefold, to 20 cents per pound. In the next two years the number of growers fell to 5.

The Impact

In the over-all experience, persons in the different groups reacted differently. While the profits were generally distributed among all the sections, the scale of cultivation of the crop varied among the different groups. In the peak year the average production of cultivators in the group of visiting businessmen was 10,000 pounds; among local producers of the higher group, 1,500 pounds; among the medium group 750 pounds; and among the lower group 600 pounds. The visiting businessmen took to tobacco cultivation as their sole business and their scale of operations and profits ranked above the rest. In the local populace the profits were well distributed, and at all levels persons had begun to take to this cash crop as a means to supplement their food crops. A new technique was learnt, and a new balance between food and cash crops attained.

However, the sudden decline led to problems of readjustment. Some of the business group continued to grow tobacco. The higher castes tried some other cash crops like sugar cane, turmeric, etc.; but most of them ultimately returned to cotton. The medium group reverted to the old crops of maize and cotton; the lower one to food crops alone.

The absence of tax in the initial stage and its modest level during the

earlier stages of development show how a taxation policy can be geared to the promotion of a cash crop, influencing even the small-scale and the medium-sized ventures. The sudden increase in the tax at a later stage demonstrates how the cultivators at the lower and medium levels may be discouraged to the point of giving up the crop altogether, although better businessmen may continue to find it profitable.

The entire episode demonstrates a genuine desire among the villagers at all levels to add a paying commercial crop to their traditional economy, weighted on the side of food crops, even though no Extension agency was at work. It shows the willingness of the smaller and the medium groups to revise their traditional attitudes and adopt changes.

At a time when campaigns at national levels are under way for teaching farmers to strike a better balance between food crops and cash crops, and when special emphasis appears to be given to the smaller and medium groups of cultivators, the lessons of such an experience as that reported here seem clearly relevant.

COST ALLOCATION AND THE DETECTION OF UNPROFITABLE VENTURES

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THE ALLOCATION of fixed and common costs and the determination of charges for services provided on the farm are always troublesome problems in accounting. Useful as conventional practices have been, they can result in cost and return estimates for individual ventures which do not guide one to the profit-maximizing position. Fundamentally, the purpose of any attempt to measure the net gain obtained or obtainable from individual activities is to provide a means of distinguishing between the profitable and the unprofitable, but when a cost of production figure is computed by charging some kind of going market rate for land or labor, rather than the marginally determined rate appropriate for a particular farm, this figure in general will lead to a non-profit-maximizing choice of ventures—if production decisions are actually based upon it. This paper illustrates the point through the use of a linear programming study of an English farm and presents a theoretically defensible solution for these problems.

We study an actual farm, typical of many in the Eastern Counties of England: a milking herd of fourteen cows, eighteen weaner pigs per year, one hundred hens, twenty-three acres of permanent pasture, twenty-one

[1] We are indebted to Dean McKee for helpful comments.

acres producing oats, beans, mangolds and clover hay as feed, and thirty-seven acres producing cash crops.[2] In order to study competitive relationships among the various enterprises considered, a normative model was designed, with dairying, poultry production and fattening pig stores as animal enterprises, and oats, wheat, barley, beans and canning peas as cash crops. Permanent pasture, ploughland, labor, and pig and poultry capacity are limited resources. Rotational requirements hold cereal acreage between 45 and 70 percent of the ploughland (not more than 35 percent in any one cereal), and roots to 10 to 20 percent. Between 20 and 35 percent of the ploughland must be in soil improvers, with clover taking not over 25 percent and peas and beans together not over 15 percent of the total ploughland.

The optimal program calls for 21 acres in wheat, 14 in barley, 9 acres each of canning peas and sugar beet, 12 cows, and 39 pigs per year. Oats and beans or their feeding equivalent are to be purchased rather than grown.

The Profitability of Individual Ventures

To determine the profitability of an individual enterprise or activity it is necessary to solve two troublesome problems: (1) determine an appropriate rate to charge as cost for the use of non-purchased resources, and (2) determine the proportion of joint costs that should be charged against each of the enterprises benefited. With respect to the first problem, it is customary to seek market prices for hired labor, rented land, etc., to assume that these factor services are approximately equivalent to the services available from resources already on the farm, and to take these "going rates" as measures of the market opportunities foregone by using one's own resources on one's own farm. With respect to the return on capital the customary charge may find more justification in convention than in actual market alternatives. Unfortunately, market alternatives, even when correctly measured, often are not the most profitable alternatives and their use may lead to unwise production decisions.

The second problem is ordinarily handled by allocating joint or common costs in proportion to direct costs, gross receipts, or some other arbitrary base, but estimates of cost and return that are consistent with profit-maximizing decisions cannot be found, in general, by applying such conventional rules. A correct allocation depends upon the economic and technological alternatives available in a particular case—more specifically,

[2] For a more detailed description (and a somewhat different model) see C. S. Barnard and V. E. Smith, "Resource Allocation on an East Anglian Dairy Farm," Occasional Papers No. 6, Farm Economics Branch, School of Agriculture, Cambridge University, Cambridge, England, April 1959.

upon the technology that would be employed in the optimal farm organization. No rule independent of the technology of the particular firm can lead to trustworthy estimates.

Conventional analysis states that for profit maximization each activity used must yield at least enough to offset the costs that could be avoided by dropping the activity, and pay at least as well as alternative activities for the resources which it consumes. To achieve these objectives the resources used by each activity must be charged to that activity at prices equal to their marginal opportunity costs. Use of input prices and joint costs not conforming with the marginal opportunity cost principle will result in cost figures for individual activities which are not consistent with optimal output decisions. Purchased inputs valued at purchase prices are measures of marginal opportunity costs, but finding such measures for inputs furnished on the farm was difficult, if not impossible, until linear programming was developed. Fortunately, the simplex method of solution of a linear programming problem proceeds by measuring marginal opportunity costs. It determines the least costly way of adjusting the optimal program for the loss of one unit of a particular input and measures the loss of net revenue that results from making these adjustments.[3]

When opportunity cost imputations determine the rates to be charged for the resources used, each activity that lowers the aggregate net revenue of the firm will fall short of recovering its own imputed costs. On the other hand, each activity that should be included in the most profitable organization will yield just enough to pay the charges. (Since the model assumes constant returns to scale for each activity, the marginally determined shares of the inputs of an included activity exactly exhaust its total net revenue.)

The aggregate charges made to all included activities equal the total net revenue the firm can earn by the optimal use of its limited resources. (If total imputed charges did not exhaust total net revenue, the level of cost imputation might be low enough to permit some activity to appear to cover its imputed costs which was not in the optimal combination, but merely a close competitor for a place there.)[4]

[3] These marginal opportunity cost figures also measure the value of the marginal product of an added unit of any resource, except at points where adding one unit of a resource changes one or more of the kinds of activities in the optimal solution. In these cases the marginal product of the loss of one unit of a resource is more than the marginal product of adding a unit.

[4] In a linear programming problem an appropriate cost imputation exists whenever the solution of the profit-maximizing problem exists. (A. Charnes, W. W. Cooper, and A. Henderson, *An Introduction to Linear Programming*, John Wiley & Sons, Inc., New York, 1953, pp. 72-74.) This imputation is unique. Given the optimal program, there is only one set of imputed cost figures that correctly discriminates among the ventures to be included or excluded.

Another requirement of conventional profit-maximization theory is that each activity used be equally profitable at the margin. As each such activity has a zero net revenue after paying the marginally imputed charges for the limited resources it consumes, the condition of equal profitability at the margin is fulfilled by the programming solution. If an activity were to have a net revenue greater than the opportunity cost valuation of the resources employed, this would indicate that its marginal profitability was greater than that of the alternative uses available, so they should be contracted and this activity expanded. In such a case the optimal combination of ventures has not yet been reached.[5]

The Animal Enterprises in an Optimal Organization

The marginal opportunity cost charges against the animal enterprises are given in Table 1. The table is based on information obtained from

TABLE 1. OPPORTUNITY COST CHARGES AGAINST THE ANIMAL ENTERPRISES: BASED UPON AN OPTIMAL ORGANIZATION

Restriction	Value of Marginal Product (£)	Pigs in Cattle Yards		Pigs in Sties		Poultry		Dairy	
		Inputs Used (21.10 pigs)	Total Value (£)	Inputs Used (18.00 pigs)	Total Value (£)	Inputs Used (100 hens)	Total Value (£)	Inputs Used (12.28 cows)	Total Value (£)
Permanent Pasture (acres)	19.970							18.78	375.14
Labor per Fortnight (hours)									
May 1		21.10		6.00		19.50		68.39	
May 2	.731	21.10	15.42	6.00	4.39	19.50	14.25	68.39	49.98
Aug. 2	.847	21.10	17.87	6.00	5.08	9.00	7.62	52.55	44.51
Sept. 1				6.00		9.00		84.22	
Oct. 1				6.00		12.00		140.70	
Oct. 2	.981			6.00	5.89	12.00	11.78	140.70	138.09
Sty capacity (pigs)	.725			18.00	13.05				
Capacity for pigs in cattle yard (pigs)		21.10							
Poultry capacity (hens)						100.00			
Sugar beet tops (cwt.)								394.11	
Mangolds (cwt.)	.132							758.75	100.30
Straw (cwt.)	.102	21.10	2.15	18.00	1.84			692.45	70.63
Hay (cwt.)	.329							343.77	113.04
Oats (cwt.)	1.297							108.04	140.13
Wheat (cwt.)	1.424					52.00	74.05		
Beans (cwt.)	1.796							94.54	169.79
Total opportunity costs of the enterprise			35.44[a]		30.25[a]		107.70		1,201.61[a]
Net revenue from the enterprise			35.45		30.24		93.53		1,201.60

[a] Differs from net revenue figure because of rounding error.

The optimal set of implicit valuations is the unique solution of that set of dual constraints which consists of those constraints that correspond to non-slack activities which appear in the optimal basis of the primal problem. The optimal combination of ventures may not be unique, but Cooper and Henderson remark that the dual values are independent of the alternate optimum programs selected. (*Ibid.*, pp. 28-29.)

[5] Comparison between the total costs and revenues incurred by an activity leads here to a conclusion concerning *marginal* profitability because the valuations are computed at the margin and we assume constant returns to scale for the activity.

the initial and final tables of the linear programming model used in planning the farm. Charges for all resources used but not listed in this table have already been deducted in computing the net revenues available from one unit of any enterprise. The leftmost column of figures gives the marginal opportunity cost valuations of the inputs to be considered here. Those which are not scarce have zero opportunity costs—for instance, labor in the first fortnight of May, September, or October.[6]

If we look at particular enterprises we see that the pig and dairy enterprises yield total net revenues sufficient to meet the opportunity cost charges, but that the poultry enterprise does not. However, fattening pig stores in the cattle yards during the summer, while able to meet competitive marginal opportunity costs for labor and straw, can only do so on a limited scale. While the yards can hold 60 pigs, to raise more than 21 would reduce the profitability of the farm. Thus there is excess pig capacity in the cattle yards, so its marginal opportunity cost is zero. Although the yards serve both cattle and pigs, none of the joint costs can be charged against the pig activity without indicating falsely that it is an unprofitable part of the whole. The venture yields no capacity rent, but without it other resources would be less well used and the total revenue of the farm would be less.

Pigs in sties meet competitive opportunity costs and leave a surplus of £13, nearly half their net revenue, to be credited to sty capacity as a kind of quasi-rent. (Net revenues from pigs in sties would have to drop nearly 50 percent, to £17.19 for 18 pigs, before sty capacity became worthless.) The positive marginal valuation of sty capacity indicates that this activity should be expanded if the capital costs of providing more sties can be adequately reimbursed by the £2.17 per year that shelter for one more pig could earn.[7]

Poultry simply do not pay for the inputs they require. The charges against them exceed their net revenue by approximately £14. The principal item, however, is wheat, charged at the selling price of £1.424

[6] Employment off the farm was not a relevant alternative in this case. Should there be opportunities for such employment, these could easily be included when formulating the original model. In order to concentrate upon the question of cost allocation we shall generally assume that this model is an accurate representation of the relevant facts. Of course all models are approximations. The precision of one's cost allocation can be controlled by the degree of care and detail employed in the model.

[7] Space for one pig at a time will house three during the year; thus $3 \times$ £.725 = £2.17. Further analysis of the solution shows that space for 30.63 pigs per year could be added before there would be any reduction in the value of an additional unit of sty capacity. To use this added capacity most profitably, pigs in cattle yards should be eliminated and the dairy herd reduced by 2.5 cows, while cash crops should expand. These conclusions refer to a pig-fattening activity carried on evenly throughout the year. Fattening bacon stores in the winter only would compete less with summer uses of labor and might prove even more formidable as a threat to the dairy venture.

per hundredweight. If we were to assume that hens were fed dross wheat with zero opportunity cost, the optimal program would include all the hens the dross wheat would feed—98, after taking account of the ¾-acre expansion in wheat required when introducing poultry into the program in an optimal way. (Pigs in cattle yards would fall to 4 and the dairy herd to 11 cows, while cash crops would expand somewhat in this new program.) However, it is incorrect to assume that dross wheat has a zero opportunity cost. It can be fed to cattle or pigs, and we cannot say which venture should be favored with it without detailed information concerning its technical substitutability for alternative feeds. If the marginal value of dross wheat in other uses were as much as £1.16 per cwt., no poultry should be raised; at a marginal opportunity cost of £1.15, hens become profitable. The most profitable allocation of dross grain was not attempted in this analysis.

The charges against the dairy venture represent solutions of more complicated allocation problems. Although sugar beet tops are an important dairy feed, none of the joint costs of producing both tops and roots are to be charged against the dairy herd. The value of their marginal product is zero for more are produced than needed. The level of sugar beet acreage has evidently not been extended in order to provide feed for the dairy cattle; no resources have been diverted from other uses for their benefit.

Straw, which can be sold at £.102 per cwt., has a positive opportunity cost which dairy revenues must cover if dairying is to be worthwhile. Moreover, receipts from the sale of wheat and barley are not as great as the total value of the resources devoted to their production; the pig and dairy ventures must be charged with the part of that cost which is left to be covered by the value of the straw consumed.

Mangolds and hay are produced specifically for the dairy herd. We expect to charge the costs of their production against the dairy project. These costs are primarily the costs of the land and labor required and cannot be determined until values are assigned to land and labor. However, as resource values are determined in such a way that the values of the marginal products of mangolds and hay are equal to the marginal opportunity costs involved in their production, charging the dairy project with mangolds and hay at their marginally imputed values gives exactly the cost allocation required.

To summarize, the opportunity costs of the dairy venture are £607.72 for the land and labor employed directly, plus £283.97 for the indirect use of land and labor in the production of mangolds, straw and hay. The £1,201.60 of net revenue from the dairy enterprise provides just enough to pay these charges (£891.69) plus the £309.92 outlay for oats and beans purchased.

Any other allocation of costs would have been misleading. Assigning part of sugar beet costs to the dairy venture would leave unallocated net revenues in beet production and losses for the dairy herd, but the expansion and contraction indicated would reduce total net revenue. Had a customary or market rate of pasture rental been used in estimating the cost of pasture land used it almost certainly would have differed from the internal rate used here, and subtracting it from dairy net revenues would have left a surplus or deficit. Neither a surplus nor a deficit would be a correct guide to changes in the level of the dairy venture, for any change from the optimal herd of 12.28 cows reduces total net revenue. Only the correct opportunity cost charges will exactly distribute the total dairy net revenue, leaving a zero surplus as the correct indication that all ventures are making equally profitable uses of resources at the margin.

Neither the buying nor the selling price of hay is appropriate for use in evaluating the profiitability of the dairy enterprise; in this instance, the true opportunity cost of hay is that of production on the farm, which lies between these two. Had the selling price of hay (£.300 per cwt.) been used as a measure of the value contributed by the resources used in hay production, some of the net revenue of the farm would have been unallocated, so the dairy venture would have shown a surplus over opportunity costs. Such a surplus means that dairying makes a more profitable use of resources than other ventures, indicating that the activity should be expanded, but as this surplus is the result of a false measure of opportunity cost it gives a false indication. The buying price (£.500 per cwt.) would have allocated too much revenue to resources used for hay and caused the dairy venture to show losses, suggesting contraction. No price other than the true marginal opportunity cost yields an accurate guide.

Whenever there is a gap between the price at which units of a resource may be added to the farm and the disposal price for such units, the true marginal opportunity cost may be anywhere at or between the limits of this gap. Since the situation is common, it is evident that even the use of readily determined market prices in making cost and return estimates may be misleading.

The Feed Crops in an Optimal Organization

The marginally determined returns or benefits from inputs produced on the farm must equal the marginally determined opportunity costs of producing these inputs in any profit-maximizing organization. Thus the opportunity cost of the inputs required for the production of mangolds is just offset by the benefits received when marginal valuations are used (Table 2). Not all of these costs must be borne by the dairy enterprise, however, for via the rotational restrictions mangold production contrib-

TABLE 2. ALLOCATION OF COSTS AND BENEFITS ASSOCIATED WITH THE PRODUCTION OF MANGOLDS, HAY, BEANS AND OATS[a]

Restriction	Value of Marginal Product	Mangolds		Clover Hay		Beans		Oats	
		Physical Quantity	Value (£)	Physical Quantity	Value (£)	Physical Quantity	Value (£)	Physical Quantity	Value (£)
Costs									
Ploughland (acres)	19.084	1.65	31.48	5.63	107.39	10.00	190.84	10.00	190.84
Labor: May 2 (hrs.)	.731	38.30	27.99	1.18	.78	18.00	13.16	.50	.37
Aug. 2 (hrs.)	.847			2.81	2.38	66.20	56.08	52.60	44.56
Oct. 2 (hrs.)	.981	27.13	26.63	7.99	7.84	6.90	6.77	6.00	5.89
Net consumption of pea and bean acreage (acres)	6.481					8.50	55.09		
Total opportunity costs of inputs provided within the model			86.10		118.39		321.94		241.65
Costs of inputs provided outside the model			19.28		19.27		97.09		99.12
Total opportunity costs			105.38[b]		137.66[b]		419.03		340.77
Benefits									
Mangolds (cwt.)	.132	758.75	100.30						
Straw (cwt.)	.102							235.30	24.00
Hay (cwt.)	.329			365.78[c]	120.28				
Oats (cwt.)	1.297							220.00	285.34
Beans (cwt.)	1.796					190.00	341.24		
Extra wheat acreage made possible (acres)	6.054	.58	3.49	1.97	11.92	3.50	21.19	3.50	21.19
Extra pea and bean acreage made possible (acres)	6.481	.25	1.60	.84	5.47			1.50	9.72
Total benefits			105.39		137.67		362.43		340.25

[a] Inputs with zero marginal valuations not listed.
[b] Differs from total benefits figure because of rounding error.
[c] Exceeds the amount charged against the dairy enterprise by 22 cwt., which is produced for the horse.

utes £5.09 to total net revenue by making possible slight expansions in wheat and pea acreage.[8] The marginal value of an hundredweight of mangolds corresponds exactly to that portion of the costs which the dairy enterprise must bear; the remainder of the costs associated with mangold production are properly charged against revenues from wheat and peas. Similarly, the value of the hay produced does not quite cover all the costs of hay production because a small fraction is reimbursed by the extra wheat and pea production revenue made possible, under the rotational restrictions, by putting 5.6 acres into clover hay.

Activities that are not sufficiently profitable to be included in the optimal program have costs that exceed their benefits. (See the analysis of bean production in Table 2.) Valuing beans at their buying price, for that measures the saving made possible by growing them, their total benefits still fall £56.60 below their total opportunity costs. Most of the difference consists of the opportunity cost (£55) of placing the limited acreage allowed for peas and beans in peas instead of in beans. If the activity of growing canning peas were not available, there would be very little sacrifice in growing one's own beans—perhaps none at all, for the marginal valuations of the resources would be altered (in general, reduced) if any desirable activity were to become unavailable.

Ten acres of oats would produce benefits only £.52 less than the opportunity costs incurred. The benefits include £31 worth of rotational benefits and £24 in value of straw.

Conclusion

The problems of cost imputation and allocation and of making relevant comparisons of the profitability of alternative opportunities are essentially one. The marginal resource valuations obtainable from a programming solution enable us to solve them both.

The method of cost allocation presented here is unconventional in two ways: 1) its strict adherence to the marginal opportunity cost principle and 2) its explicit treatment of some of the less obvious relationships that are often ignored or treated quite casually—for instance, rotational relationships or the use of straw. Strict adherence to the marginal principle means that market valuations are not used unless there is actually a market alternative. Land, labor, hay and mangolds cannot be valued at

[8] Rotational restrictions have limited wheat and pea acreage to such an extent that the freedom to plant one extra acre of wheat would be worth £6.05 per acre, while similar relaxation of the limit on peas and beans would be worth £6.48. Now that it is possible to measure the annual cost of adhering to a given rotational restriction we are better able to ask whether the long-run benefits really warrant the sacrifices involved. Moreover, we can tell the scientist which restrictions require the most sacrifice.

some kind of average market rate, but must be valued at what they actually can contribute to the net revenue of the farm.

Whether it is worth while to take explicit account of relationships that are ordinarily neglected is a matter for the informed judgment of the analyst. The model can include or ignore as much detail as is desired: in this model we used an approximation with respect to straw and ignored the relationships that grow out of the use of dross grain. Cost analysis for individual ventures may reveal the effects of some of these decisions concerning matters usually ignored and give the analyst a means for estimating what alternative treatments would have accomplished. The importance of alternative uses for dross wheat in determining the desirability of raising poultry is an example.

The individual evaluations used in these analyses will also determine whether enterprises not included in the model should be introduced. Any enterprise that will not cover resource charges made at these marginal opportunity costs should be rejected, but any enterprise that would more than repay them should be included in the program. In the general case, to determine the optimal way in which to add such a new enterprise requires a recomputation of the model, expanded to include the new activity, and will ordinarily result in new marginal resource valuations.

Perhaps the most important consequences of cost analyses such as these are a better understanding of the relationships prevailing among the various ventures used and available, and a better understanding of the limitations of cost estimates based upon other principles of resource valuation and cost allocation. Anyone concerned with efforts to establish cost-of-production figures should have the insight into the problem which this method of analysis can give.

It is true that our results are stated with a degree of precision which the quality of the data available may not warrant, but all methods are limited by the data available and most accounting estimates are stated with equal precision. That programming methods can make use of precise data and deal with minor relationships as well as major ones is certainly not a disadvantage. It is also true that solutions reflect only the relationships built into a model, but this is true of any system of accounting or cost analysis. The cost allocation will be incorrect if the model is incorrect—that is, if the solution is not really optimal for the firm. Constructing a satisfactory model is a problem in itself, but the use of programming models in seeking profit-maximizing positions has already proven itself. Programming has the advantage of being explicit about the relationships which it considers and of valuing opportunity costs in a consistent and precise way—indeed, in the only way that will determine correctly whether any specific activity is worth undertaking.

FERTILIZER DEMAND IN THE SOUTH ATLANTIC AND EAST NORTH CENTRAL REGIONS

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IT IS the purpose of this paper (1) to summarize a study of fertilizer demand conducted at North Carolina State College and (2) to present some reflections on the research to date on the demand for fertilizer.

The North Carolina State College Study

The chief objective of the North Carolina study was the derivation of equations for predicting fertilizer consumption in the year ahead for two regions of the United States.[1] It was expected that such prediction equations could be used, with the judgment of fertilizer producers, to arrive at more accurate forecasts of fertilizer consumption than previously could be made. The South Atlantic[2] and East North Central regions were chosen because of differences in their historical pattern of increase in consumption and because they are the two regions of greatest fertilizer consumption in the United States.

Predictive variables considered in this study fall into five general classes: (1) the price of output, (2) the price of the input specifically being considered, (3) the prices of associated (substitutable or complementary) inputs, (4) the units of the fixed input to which the variable input is applied, and (5) factors which limit the farm firm in attaining the equilibrium conditions.

Twenty different variables were examined in various combinations. Those which were included from the first class mentioned above were an index of all crop prices and a weighted index of crop prices for the three most important crops in the region. In general, either non-significant or negative coefficients were obtained with these two variables.

An index of fertilizer price per unit of plant nutrient was used and it proved highly useful. Because of the predictive nature of the problem,

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[1] John R. Brake, *Prediction of Fertilizer Consumption in Two Regions of the United States,* unpublished Ph.D. thesis, August 1959, North Carolina State College, Raleigh. The project was supported by a grant from the National Plant Food Institute to the North Carolina Agricultural Experiment Station. The thesis was completed under the direction of Richard A. King, M. G. Mann Professor of Agricultural Economics.

A more popularized presentation of the prediction aspects are presented by Richard A. King, "How to Predict Fertilizer Sales," *Plant Food Review,* Fall 1959, p. 9.

[2] The South Atlantic region is defined to be the five-state region consisting of Virginia, North Carolina, South Carolina, Georgia, and Florida.

however, it was necessary to use the September 15 price of fertilizer in predicting fertilizer consumption for the fiscal year ending the following June 30. An examination of contracting procedures between processors and producers indicated that this price should reflect fairly well what could be expected in the following few months.

An index of land values was the chief variable used from the third class mentioned above. As expected, a substitution relationship was indicated between land and fertilizer as shown by a positive coefficient for land values. Prices of farm labor and of farm machinery were not included in the analysis.

Three different variables were used from the fourth class of variables. They were (1) an index of planted acreage of all crops, (2) an index of planted acreage of the three most important crops in the region weighted by application rates per acre, and (3) the planted acreage of a single crop such as tobacco or corn. The first two of these were not useful for our purposes for two reasons. First, planted acreages of most crops would themselves need to be predicted for use in a prediction model. Second, the coefficient was generally non-significant at the five percent level and was negative in several cases.[3] The reason for this appeared to be that, while planted acreage was reduced from 1950 through 1958, farmers were offsetting this reduction with increased fertilization.

A negative coefficient for acreage planted, however, is not a bona fide substitution relationship in the economic sense. A valid substitution relationship would have fertilizer quantity a function of associated input prices. Other things equal, it is to be expected that fertilizer consumption would vary directly with crop acreage. This was, in fact, observed when changes in tobacco acreage were included for the South Atlantic region. When corn acreage was similarly included in the East North Central region, the coefficient was not significant at the five percent level. The difference seemed to be that about 100 percent of the tobacco acreage is fertilized whereas the proportion of corn acreage that was fertilized changed rapidly enough to offset the change in acreage planted. Evidently one of the important "other things" which are not equal for most crops is the proportion of acreage that is fertilized.

Finally, the class of variables most difficult to deal with is those which limit the firm in attaining equilibrium. Since, under conditions of limited operating capital, farmers may be unable to fertilize at the most economical rates, farm income was included as a variable in the analysis. A number of other important variables in this class such as level of knowledge of farmers, technological changes, and governmental influences

[3] A negative coefficient was observed also in the work of Earl O. Heady and Martin H. Yeh, "National and Regional Demand Functions for Fertilizer," *J. Farm Econ.* 41:332-48, May 1959.

were not specifically included in the analysis. More will be said of these later.

Two deflators were used: an index of prices paid by farmers and an index of wholesale prices. Fertilizer consumption was defined as combined sales of the three primary plant nutrients during the fiscal year ending June 30.

Three different models were fitted by least squares regression procedures. These were as follows:

(1) an equation of the form,

$$Y = b_0 + b_1X_1 + b_2X_2 + \cdots + b_nX_n$$

(2) a regression on first differences with the constant specified to be zero,

$$\Delta Y = b_1\Delta X_1 + b_2\Delta X_2 + \cdots + b_n\Delta X_n$$

and (3) a distributed lag equation of the form,

$$Y_t = b_0 + b_1X_1 + b_2Y_{t-1}$$

Equations were fitted both in absolute values and in the logarithms of the variables, but the use of absolute values was preferred from a statistical standpoint. The standard error of prediction was smaller, and the assumption of homogeneous variance over time appeared to be more nearly satisfied using the absolute values.

South Atlantic Region:

$$(1)\qquad \hat{Y}_t = \underset{}{96.361} + \underset{(.1117)}{.7068(FI)_{t-1}} - \underset{(.000026)}{.000091(FI)^2_{t-1}}$$
$$- \underset{(.7229)}{2.9228P_{c(t-1)}} + \underset{(1.8774)}{5.7009P_{w(t-1)}}$$

$$(2)\qquad \Delta\hat{Y}_t = \underset{(.0518)}{.1377\Delta(FI')_{t-1}} - \underset{(.9063)}{4.1768\Delta P_{f(t-1)}} + \underset{(.0505)}{.1197\Delta T_t}$$

$$(3)\qquad \hat{Y}_t = 816.082 - \underset{(5.2398)}{8.6325P'_{f(t-1)}} + \underset{(.1073)}{.7477Y_{t-1}}$$

East North Central Region:

$$(4)\qquad \Delta\hat{Y}_t = \underset{(1.4029)}{4.0075\Delta V_{t-1}} - \underset{(1.3876)}{4.9687\Delta P_{f(t-1)}}$$

$$(5)\qquad \hat{Y}_t = 424.974 - \underset{(1.4281)}{4.9003P'_{f(t-1)}} + \underset{(.0389)}{.9326Y_{t-1}}$$

where

$\hat{Y}_t$ is predicted consumption of primary plant nutrients in thousand tons for the fiscal year ending June 30, year t;

FI_{t-1} is total farm income in millions of dollars by region for the calendar year ending December 31, year $t-1$;

$P_{c(t-1)}$ is an index of crop prices for November 15, year $t-1$;

$P_{w(t-1)}$ is an index of wholesale prices for the U. S. on November 15, year $t-1$ (1947–49 = 100);

Δ is the change from the previous year to the year indicated by the subscript of the variable;

$FI'_{(t-1)}$ is cash receipts from crops and government payments, year $t-1$; and is deflated by an index of wholesale prices (1947–49 = 100);

$P_{f(t-1)}$ is an index of fertilizer price on September 15, year $t-1$, deflated by an index of wholesale prices (1947–49 = 100);

ΔT_t is the change in planted acreage of tobacco from year $t-1$ to year t, rounded to the nearest ten thousand acres but coded in thousands of acres (within the limits specified, this change can be quite accurately estimated the fall before planting under the present government program);

$P'_{f(t-1)}$ is an index of fertilizer price on Septmeber 15, year $t-1$, deflated by an index of prices paid by farmers (1910–14 = 100);

V_{t-1} is an index of farm real estate value for the region on November 15, year $t-1$, deflated by an index of wholesale prices.

Data for equation 1 include the years 1930-57. Data for equation 3 are for the years 1944-58. All others include the years 1930-58.

Equation 1 is presented more for the purpose of comparison than for serious consideration. While all four coefficients in this equation were significantly different from zero at the one percent level, the negative coefficient for crop prices was unsatisfactory since it is expected that producers would vary consumption directly rather than inversely with crop prices. The inclusion of a deflation term in the manner used may be somewhat questionable. The equation was included to illustrate and contrast its apparently better fit by R^2 standards (.982) and its relatively poor predictive ability, as will be shown later.

The coefficient of determination, standard error of prediction, significance level of coefficients, and the Durbin-Watson test for serial correlation were four of the criteria used in evaluating the fitted regression equations. A fifth criterion was a comparison of the stability of the coefficients throughout the 1950's as new observations were added. The question posed here was, how well would fertilizer consumption have been predicted during the 1950's using these equations but using only the data that were available at the time? Hence the data through 1950 were used

TABLE 1. EFFECTS ON THE REGRESSION COEFFICIENTS OF CHANGING THE TIME PERIOD FOR WHICH REGRESSIONS ARE FITTED[a]

Equation No.	b	Fiscal Year Ending June 30—								
		1950	1951	1952	1953	1954	1955	1956	1957	1958
1	b_0	1.891	15.043	77.104	112.588	112.378	108.593	101.088	96.361	121.507
	b_1	.8238	.8193	.7466	.7194	.7188	.7259	.7052	.7068	.6759
	b_2	− .00016	− .00014	− .00011	− .00009	− .00009	− .00009	− .00009	− .00009	− .00008
	b_3	− 2.1500	− 2.7910	− 2.9356	−3.0506	−3.0410	−3.2053	−2.9388	−2.9228	−2.5909
	b_4	5.1812	6.0018	5.7123	5.4438	5.4389	5.7139	5.6472	5.7009	4.9403
2	b_1	.1287	.1371	.1383	.1435	.1428	.1404	.1341	.1372	.1377
	b_2	− 4.0442	− 4.3067	− 4.3529	−4.1172	−4.1113	−4.0754	−4.1237	−4.1790	−4.1768
	b_3	.1233	.1333	.1331	.1233	.1238	.1221	.1275	.1198	.1197
3	b_0	1359.333	1185.209	930.276	793.351	825.575	804.374	858.301	860.987	816.082
	b_1	−11.8132	−12.0514	−10.1938	−9.0261	−9.3392	−9.1564	−9.5573	−9.6217	−8.6235
	b_2	.3667	.5778	.7263	.7947	.7811	.7915	.7613	.7626	.7477
4	b_1	1.7590	2.7435	3.4825	4.6647	4.4312	4.4282	3.8854	3.9665	4.0075
	b_2	− 3.5135	− 4.5045	− 5.2109	−5.4056	−5.2195	−5.2174	−4.8318	−9.9402	−4.9687
5	b_0	536.541	916.779	154.480	40.646	252.021	331.345	415.497	417.676	424.974
	b_1	− 5.9676	−10.3667	− 1.8966	− .6528	−2.9958	−3.8721	−4.7990	−4.8230	−4.9003
	b_2	.7966	.6401	1.0788	1.1493	1.0309	.9862	.9381	.9373	.9326

[a] Equations 1, 2, 4, and 5 are based on data for the period 1930 through the year listed in the column heading. Equation 3 is based on data from 1944 through the year listed in the column heading.

TABLE 2. COMPARISON OF ACTUAL, FITTED AND PREDICTED CONSUMPTION OF PRIMARY PLANT NUTRIENTS IN THOUSAND TONS, SOUTH ATLANTIC AND EAST NORTH CENTRAL REGIONS, 1951–58[a]

Equation No.	Consumption	Fiscal Year Ending June 30—							
		1951	1952	1953	1954	1955	1956	1957	1958
		South Atlantic							
	Actual	1232.8	1291.0	1337.0	1336.9	1362.0	1346.1	1385.6	1347.0
1	Fitted	1221.7	1284.1	1281.2	1334.0	1292.9	1377.8	1391.1	1396.7
1	Predicted	1097.7	1164.7	1207.7	1337.9	1293.9	1395.0	1390.8	1414.7
2	Fitted	1165.7	1267.7	1250.3	1324.9	1328.1	1378.5	1352.3	1348.2
2	Predicted	1163.4	1268.5	1247.8	1324.7	1327.2	1378.3	1350.2	1348.4
3	Fitted	1140.1	1378.6	1317.2	1335.0	1347.4	1375.2	1381.4	1407.6
3	Predicted	1089.0	1243.1	1308.4	1344.1	1352.5	1383.3	1380.4	1422.1
		East North Central							
	Actual	954.0	1138.0	1342.9	1401.1	1446.1	1426.2	1495.2	1552.0
4	Fitted	875.4	1005.6	1160.7	1318.7	1442.5	1505.7	1463.0	1543.7
4	Predicted	842.8	996.7	1151.5	1315.2	1446.7	1511.6	1462.2	1543.5
5	Fitted	886.2	1050.0	1219.6	1402.9	1463.8	1510.3	1500.8	1567.0
5	Predicted	829.5	964.5	1278.1	1547.0	1530.5	1546.5	1501.9	1570.8

[a] Fitted consumption is that obtained by using 1958 coefficients for all years. Predicted consumption is obtained with coefficients based upon data from 1930 (1944 for Equation 3) up to—but not including—the year of prediction.

to fit the equations and to predict 1951 consumption. Then data through 1951 were used to refit the equations and to predict 1952 consumption. This was repeated for each year through 1958.

It is evident from Table 1 that coefficients from some equations tended to fluctuate more than others. Two things are noticeable. One is the tendency for the first difference equation coefficients to remain relatively constant compared to the other equations. Second, there is a tendency for the coefficients in equations for the East North Central region to vary more than in equations for the South Atlantic region.

As could be expected, the changing coefficients of the equations had an effect on the resulting predictions of fertilizer consumption. Table 2 presents a comparison of the actual consumption, the predicted consumption by the method described above and the consumption estimated by calculating each year's consumption with the single set of coefficients obtained in the 1958 solution. Estimating each year's consumption by the single 1958 solution leads one to believe he has a better prediction device than he in fact has. The fitted values are generally closer to the actual consumption than the predicted values in six or seven of the eight years. It may be noted also that the first difference equations (2 and 4) tend to have predicted and fitted values the closest together, as one would anticipate from the stability of the coefficients. In equation 1, the predicted values were much poorer than would be expected on the basis of R^2, for example.

Equations 2 through 5 were believed by the author to be the most useful. The signs of the coefficients are consistent with the logic of the relationship and the various criteria of evaluation are relatively well satisfied. Putting all equations on a comparable basis, the adjusted coefficients of multiple determination for the five equations were .982, .979, .950, .978 and .991 respectively.

Another result worthy of note is the coefficient for changes in tobacco acreage of .1197. Since both fertilizer consumption and tobacco acreage are coded in thousands, this coefficient indicates an average per acre change at the margin of about 240 pounds (.1197 ton) of plant nutrients. This average application rate was realized about 1952, and as an average over the period covered, the coefficient is very satisfactory.

The equations provide evidence that in both regions the real price of fertilizer is an important factor affecting fertilizer consumption. In addition, the first difference equations give some substance to the hypothesis that different factors were important in the two regions. Crop income in the South Atlantic region had a significant coefficient at the five percent level in nearly every equation in which it was included. This implied that there had been an effective operating capital limitation in the re-

gion. In the North Central region, contrarily, the coefficient of income was not significant at that level in any of the equations in which it was included. A second difference was that inclusion of tobacco acreage improved the equations for the South Atlantic region, but a similar attempt to use planted acreage of corn in the East North Central region did not prove useful.

The elasticity estimates by the equations should not be considered of great importance. The purpose of the study was to develop short-run prediction equations rather than to provide estimates of structural parameters. With this in mind, the estimates of short-run elasticity may have some merit, but the estimates of long-run elasticity are particularly suspect. However, for those who are interested in a comparison, the results of this study did tend to reinforce the findings of previous workers.[4] (1) The demand for fertilizer in the South Atlantic was more inelastic than in the East North Central region. (2) With distributed lag equations, the elasticity is near −.5 in the short-run (−.480 and −.571 as estimated by equations 3 and 5 respectively) and long-run elasticity is somewhat larger than −1 (−2.02 and −9.11 by the same two equations). (3) If only a single price elasticity estimate is made, the estimates are −.83 for the South Atlantic and −1.47 for the East North Central by equations 2 and 4 respectively.

Some Reflections on Fertilizer Demand Studies to Date

One of the first points that one notices in studying fertilizer demand is the strong trend in fertilizer consumption. In fact, from 1930 through 1957, the simple trend model,

$$Y_t = bY_{t-1}$$

gives an R^2 of .953 for the South Atlantic region and an R^2 of .986 for the East North Central region. For aggregate U. S. consumption, the trend model results in an R^2 of about .987 when using 1911-57 data or an R^2 of .989 for 1930-58 data. While the trend model is not very satisfactory with respect to explanation of why fertilizer consumption changes, it may serve as a base point for purposes of comparison with results of demand studies.

None of the work to date has made a significant improvement over the trend model in respect to goodness of fit. The R^2 values for these demand studies look good in absolute terms, but the author believes further improvement could be expected from continued study for two reasons: (1)

[4] Zvi Griliches, "The Demand for Fertilizer: An Economic Interpretation of a Technical Change," *J. Farm Econ.*, 40:591-606, 1958; Zvi Griliches, "Distributed Lags, Disaggregation, and Regional Demand Functions for Fertilizer," *J. Farm Econ.*, 41:90-102, Feb. 1959; and Heady and Yeh, *op. cit.*

little improvement over the naive trend model to date and (2) a standard error of prediction in studies to date of 3½ to 5 percent of current consumption levels.

Probably the biggest contribution of these demand studies has been the theoretical and economic interpretation of the models. The application of a distributed lag model by Griliches and its interpretation with resulting estimates of short- and long-run elasticities was an important start. The work of Heady and Yeh gave further insights into differences among regions with respect to a number of variables. The North Carolina study tends to corroborate the findings of these other two works with respect to price elasticities. In addition, it provides some evidence of differences between two specific regions and provides a more complete evaluation of possible prediction uses of a number of equations.

Experience with this problem points up several fundamental difficulties, of which data problems are a big segment. Earlier it was mentioned that when acreage of crops (or an index thereof) was included as a variable, it often had a negative coefficient. Data for 1947, 1950 and 1954 give rather strong evidence that this is due to a combination of three things: (1) an increasing proportion of acreage fertilized, (2) greater application rates per fertilized acre, and (3) a decreasing total crop acreage over a part of the period when these other two influences were most pronounced. A great contribution could be made by more and improved data for (1) proportion of acreage fertilized, by crop and state, and (2) rates of application per fertilized acre, by crop and state.

There are questions that deserve consideration with respect to deflators used in studies of this nature. Each of the three studies mentioned has used a deflator for fertilizer price. Heady and Yeh used a wholesale price index, Griliches used an index of prices received for crops, and the North Carolina study used both an index of wholesale prices and an index of prices paid by farmers in various equations. These deflators may be sources of bias. Deflation by an index of crop prices which are weighted by crop acreage or crop total value may be somewhat different in its effect than if it were weighted by quantities of fertilizer used per crop. Also, an index of prices paid by farmers has fertilizer price included in the index and, therefore, gives biased results. However, the similarity of results where they are comparable among the three studies (price elasticity estimates for instance) suggests that these biases may be less important in practice than in theory.

Increased attention should be given to the influences of technological change, government programs, and changes in the level of farmers' knowledge. At least three different specifications have been made as to the manner in which these variables affect consumption. The distributed

lag models specify a reaction to technological change that affects consumption in a curvilinear manner.[5] Secondly, a linear time trend has been used to allow for effects of unspecified variables.[6] Thirdly, in some models, such as equations 2 and 4, above, no allowance has been made for specific inclusion of these variables. If these three factors are as important as seems likely, they deserve more specific study.

It is the author's impression that effects of technological changes, levels of knowledge, and government programs have been of much importance and that the estimates of effects of the specifically considered economic variables are over-estimates. It is my belief that a return to previous levels of prices—even with the estimated allowances for non-included variables—would not return fertilizer consumption to the accompanying previous levels. It follows that the "true" price elasticities are even more inelastic than present estimates indicate.[7] Perhaps the elasticities should be considered as upper bounds rather than unbiased estimates.

Possible improvements of results in future fertilizer demand studies center around the problem of disaggregation. While Griliches indicated that a regional approach using the same model did not contribute much, if any, improvement over the use of a national aggregate,[8] it is still reasonable to expect that attention to demand differences among regions or states (with respect to crops, for example) could be relatively worthwhile. The real benefits from disaggregation would appear to be possible, first, by exploiting area differences which, at a higher level of aggregation, may be relatively unimportant or difficult to define and, second, by using different methodological approaches. In the continuation of the North Carolina project, one of the means of trying to improve the results is disaggregation to state levels.

Eventually some further attention will need to be given to the influence on fertilizer demand of the acreage of specific crops grown. It may be desirable to give attention to the demand for individual plant nutrients rather than the total weight of all plant nutrients. It is expected that nutrient proportions may be fairly constant for individual crops within fairly small geographic areas. Finally, improved and increased data with respect to proportion of acreage fertilized and application rates per fertilized acre would enable one to examine some functional relationships influencing these two variables. Work of this sort could be both informative and rewarding.

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[5] See either article by Griliches, *op. cit.*

[6] See Heady and Yeh, *op. cit.*

[7] This would be consistent with farm survey findings of C. R. Berry, *An Economic Analysis of Fertilizer Marketing and Pricing with Particular Reference to Indiana*, Ph.D. Thesis, Purdue University, 1958 (University Micro-films, Ann Arbor).

[8] Griliches, *op. cit.*, Feb. 1959, p. 100.

In summary, work to date has furnished evidence that changes in fertilizer consumption can be attributed to various economic factors. However, there is some question whether the economic influences have been overestimated and to what extent technology, government and knowledge affect the results. While high coefficients of multiple determination can be obtained, these represent only slight improvements over a simple trend model. Standard errors of estimate have been rather high, generally in the range of 3½ to 5 percent of current consumption levels. With some improvement in both data and models, it appears that further refinement in results could be expected.

FARM INCOME TAX COMPLIANCE

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IT IS generally believed that farm income tax compliance is somewhat less than perfect. Agreement is lacking, however, on the extent of noncompliance, its causes, and on the corrective measures which might be applied to improve the level of farm income tax compliance. This report summarizes a recent study which approached the question of farm income tax compliance at the level of the individual farm operator, in the belief that research on this level could provide needed information on the causes and possible cures for such noncompliance as may exist.

A number of tax compliance studies have been conducted to measure compliance for the nation as a whole.[1] As a rule, these studies have taken aggregate data on farm receipts and expenditures and adjusted them to conform with income tax requirements. Results of these studies ranged from the conclusion that only around 36 per cent of net farm income appeared on federal tax returns to the view that farm income tax compliance may approach the 90 per cent level, not differing greatly from the

* A complete report of the study reported in this article is contained in the author's doctoral dissertation, "The Income Tax Compliance of Farm Income," University of Wisconsin, 1958.

[1] Selma F. Goldsmith, "Appraisal of Basic Data Available for Constructing Income Size Distributions," *Studies in Income and Wealth,* Conference on Research in Income and Wealth (New York: National Bureau of Economic Research, 1951), p. 301.

Daniel M. Holland and C. Harry Kahn, "Comparison of Personal and Taxable Income," in U.S. Congress, Joint Committee on the Economic Report, *Federal Tax Policy for Economic Growth and Stability . . .* , 84th Cong., 1st Sess., 1955, p. 317.

U.S. Department of Agriculture, Agricultural Research Service, Publication No. 43-11, *The Impact of Federal Income Taxes on Farm People* (Washington: U.S. Govt. Print. Office, July 1955), p. 31.

Frederick D. Stocker and John C. Ellickson, "How Fully Do Farmers Report Their Incomes?" *National Tax Journal,* XII (June 1959), p. 126.

compliance of other types of unincorporated private business. For the present discussion, however, the important point is that the use of aggregate data on farm compliance may conceal certain details of the problem which hold the key to the sources of compliance difficulty and to the means for their correction.

Procedure

The study here reported dealt with 1954 and 1955 farm incomes of farm operators located in three towns (townships) in southern Wisconsin. Real and personal property tax assessments were consulted to assist in the identification of these farm operators and to provide a guide to the productive potential of their farms. The farm income of these farm operators was estimated and compliance scores were determined by dividing reported farm income by estimated farm income. In the three towns, approximately 500 farm operators apparently were obligated to file and 486 of these actually did file state income tax returns, from which the compliance computations were made.

Basic information for the estimation of farm income was obtained directly from the businesses or marketing intermediaries to which the farmer sold his production, or from government agencies to which the farmer was required to provide production information. From these data, tabulations were made of products sold by individual farm operators and of dollar amounts actually paid to them.

As might be expected, the information obtained from market intermediaries was more complete for some farm products than for others. Tobacco receipts data, for example, were obtained from the government acreage allotment agency and were considered substantially complete. Also, information on dairy product sales (which accounted for more than half of the gross receipts of the farms studied) exhibited a high degree of completeness. Incompleteness was clearly evident, however, for some dairy production and for receipts from livestock, poultry, eggs, and miscellaneous other sources (crop sales, machine and custom work, sheep and wool sales, cash rent, government payments, gasoline tax refunds, etc.).

The tabulation of market information on a farm-by-farm basis did not mean that a separate income estimate could be made for each enterprise. It did mean, however, that market receipts could be related to the local property tax enumeration for those farms for which a complete market tabulation was available for a particular commodity. This relation between market receipts and the property tax enumeration was then used to make an aggregate estimate for the farms studied. Since property tax expansion was inappropriate for the miscellaneous category, these esti-

mates were based on published county statistics and on model tax returns filed under the supervision of a local farm management association.

After compliance in reporting gross farm receipts had been determined, allowable farm deductions were estimated for the group on the basis of a ratio of allowable farm deductions to reportable gross farm receipts. This ratio was determined according to tax returns filed under supervision of a management association for farms in the same area as those under analysis. These returns generally were regarded as models of accuracy. Moreover, their use insured that the deduction ratio conformed with income tax definitions of reportable receipts and deductions.

After allowable farm deductions had been estimated, net farm income was computed by subtracting allowable farm deductions from reportable gross receipts and compliance scores were determined by comparison with returns actually filed. Finally, tax liability compliance was estimated by comparing the tax actually reported on the filed tax returns with the tax which would have been payable had the estimated net farm income been fully reported.

Compliance in Reporting Gross Farm Receipts

Separate scores were computed for each of the receipt categories used on the income tax return, thus permitting compliance comparisons among the various sources of farm receipts. Estimated compliance, by receipt source, is shown in Table 1.

TABLE 1. COMPLIANCE IN REPORTING GROSS FARM RECEIPTS, FARM OPERATORS IN THREE SOUTHERN WISCONSIN TOWNS, 1954 AND 1955

Receipt Source	Fully Filing Farms	All Farms
	Percent	
Dairy products	93.4	85.6
Swine	78.0	72.9
Cattle and calves	72.6	67.1
Tobacco	95.4	89.9
Poultry and eggs	50.0	46.8
Miscellaneous	68.9	66.1
All sources combined	81.8	75.8

In comparing scores for different receipt sources, a distinction was made between "all farms" and those termed "fully filing farms." Scores for "all farms" involve both underreporting by operators who did file returns and the failure of some operators to file although obligated to do so. Thus, although the "all farms" category is useful in appraising over-all reporting compliance, comparisons, among receipt sources should be made only for farms from which all operators actually filed tax returns.

Among the receipt sources studied, tobacco and dairy products yielded scores of 95.4 per cent and 93.4 per cent respectively, considering only the "fully filing farms." However, compliance in reporting livestock, poultry, and egg receipts was much lower, ranging downward from 78.0 per cent. In attempting to explain the variation between these two groups, it seemed significant that high compliance was associated with those products for which good farm accounting was required either by law (as under the tobacco acreage program) or by well established marketing and production procedures (as was the case for dairy production). Poor compliance, on the other hand, appeared where marketing connections tended to be irregular or where several buyers might be involved. If irregular marketing leads to incomplete farm accounting, incomplete tax reporting could be a natural consequence.

Compliance in Claiming Farm Deductions

Since farm deductions include a great variety of small, cash transactions, estimates could not be based on information obtainable from farm suppliers. Instead, allowable farm deductions were estimated by means of the ratio between allowable farm deductions and reportable farm gross receipts. According to tax returns filed under the supervision of the local farm management association, deductions (exclusive of interest) were estimated to average 71.9 per cent of reportable gross farm receipts.[2] Applying this ratio to gross receipts estimated for the farm operators studied indicated that operators who did file tax returns actually *failed* to claim 13.2 per cent of their allowable farm deductions.

As in the analysis of gross receipts reporting, noncompliance in claiming deductions (in this case favoring the government) was thought to be explainable in terms of the inadequacy of many farm accounting systems, since it seemed reasonable to expect that farm operators would claim all allowable deductions of which they were aware.[3] Thus, although deductions may have been "padded" in individual cases, these instances were not sufficient to counterbalance the general underclaiming of deductions for the aggregate of farm returns studied.

Compliance in Reporting Net Farm Income

Compliance in reporting net farm income was determined by subtract-

[2] Interest was excluded on the ground that it was mostly related to the ownership of the farm and not to the gross receipts of the farm. This interest was allowed as a personal deduction for the farm operator.

[3] The compliance figure excluded returns where deduction claims were obviously absent or incomplete because the level of gross receipts less exemptions indicated no net tax liability, regardless of deductions.

ing estimated allowable farm deductions from estimated gross farm receipts and comparing the result with the comparable figure taken from tax returns actually filed. This yielded compliance scores of 69.8 per cent for those operators who filed returns and 64.6 per cent when both filers and nonfilers were considered.

Compliance in reporting net cash farm income was below compliance in reporting gross farm receipts in spite of the underclaiming of farm deductions. This apparently anomalous result arose because of the "leverage effect" exerted by the high ratio of deductions to gross farm receipts. For example, if net income were 25 per cent of gross receipts, a 5 per cent omission of gross receipts would produce a 20 per cent underreporting of net income, for a "leverage effect" of 4, assuming that deductions were correctly claimed. Similarly, if net income were one-third of gross receipts, the "leverage effect" would be 3, etc. Among the farm operators studied, net farm income reporting compliance would have been only 13.9 per cent if farm deductions had been fully claimed. However, the underclaiming of deductions did partially counterbalance the leverage, although it was not sufficient to overcome it completely and yield a higher score for net income than for gross receipts.

On a dollar for dollar basis, of course, errors in determining tax liability have the same result whether they arise through errors in reporting gross receipts or in reporting deductions. However, the "leverage effect" does illustrate the great importance of gross receipts compliance in farm income taxation.

Tax Liability Compliance

For many farm operators, personal deductions and exemptions cancel all net tax liability so that the question of reporting compliance is rather academic so far as tax revenue is concerned. Of course, the amount of unreported farm income which is without any tax liability depends on the level of deductions and exemptions allowed in the particular tax jurisdiction. Moreover, the tax liability on that portion of unreported net income not cancelled by deductions and exemptions depends on the bracket graduation of tax rates and the distribution of unreported income among these brackets.

The estimation of compliance in reporting tax liability was undertaken as follows. For the farm operators studied, personal deductions, exemptions, and nonfarm receipts were accepted as listed on the tax return. For those returns reporting no net tax liability, a net income equivalent was computed to match the exemptions and personal deductions not used because of the low level of net income actually reported. According to

this calculation, the unreported net farm income which might have been without any tax liability could, at most, have amounted to 53 per cent of the total net cash farm income estimated to have been unreported. (This calculation, in effect, implicitly assumed that unreported net farm income was distributed among individuals so as to utilize all previously unused exemptions and deductions. This situation, of course, may not, in fact, have been the case.)

For the years in question, the lowest bracket tax rate was 1.2 per cent of net taxable income after personal deductions and exemptions. Assuming that only 47 per cent of the total unreported income had any tax consequence at all, and that this entire 47 per cent was taxable at the lowest bracket rate of 1.2 per cent, the effective rate of tax on the unreported farm income would have been 0.564 per cent (0.47×0.012). However, the effective tax rate actually reported was only 0.496 per cent. If the effective tax rate on unreported farm income had been the same as that on the income actually reported, the tax liability compliance score would have been the same as the compliance score for reporting net farm income. However, since the effective rate of tax on unreported farm income was at least 0.564 per cent, it was evident that *tax liability* compliance on farm income was less then *reporting compliance* on farm income, that is, less than 64.6 per cent.[4]

Conclusions

The study outlined above treated a relatively small group of farm operators in a rather specialized agricultural area. Consequently, its quantitative findings may not have great relevance to other areas or to the nation as a whole.

Certain qualitative findings, however, do merit broader consideration. Particularly striking was the finding that, in the aggregate, farm deductions were *underclaimed* so that net farm income noncompliance generally arose from a failure to report all gross farm receipts, rather than from any overstatement of farm deductions. For tax administration purposes, the importance of this finding is readily apparent and could lead to a consideration of the use of information returns filed by the purchasers of farm products.

Also of importance was the finding that noncompliance generally ap-

[4] A more precise calculation of tax liability compliance could not be made in the absence of information on the amount of unreported farm income attributable to each farm operator studied. It also should be noted that the study dealt only with the *farm* income of this group of farm operators. Thus, the tax compliance of the operators themselves could be better or worse than that indicated above, depending on their compliance in reporting income from nonfarm sources.

peared through omissions or incompleteness in listing both farm receipts and farm deductions. If these errors of omission can be attributed to an inadequacy of farm accounting, a promising avenue toward improvement would be through programs designed to assist the farmer in maintaining an adequate set of farm records. If good accounting improves farm profitability as well as tax compliance, accounting improvements could offer a net gain to all concerned.

PUPIL RESPONSE TO CHANGES IN SCHOOL MILK PRICES IN WISCONSIN

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THE controlled experiment conducted in March and April of 1955 to determine pupil response to pricing milk in two city school systems gave some useful results on school milk demand, but left unanswered the question of how persistent this price response was over a longer time period.[1] The present note gives the highlights of an analysis of response to price reductions in the whole of the Wisconsin public school system for a two-year span, one year of which followed the date of the experiment.

As indicated by the following tabulations, results from the experimental study indicated that response to reduced prices was far greater than that usually found in aggregative studies of fluid milk prices:

	Increase in consumption		
Price reduction	*Madison Elementary*	*Milwaukee Elementary*	*Milwaukee High School*
Per cent	*Per cent*	*Per cent*	*Per cent*
25	40.4	10.5	−20.1
50	69.5	24.6	+23.0
75	158.9	60.3	—

It was determined that part of this increase came because of improved availability, a factor which had more effect than price when price reductions were relatively small. It also was shown that increases in milk consumption tended to be low for schools that had higher rates of pre-

[1] Hugh L. Cook and Harlow W. Halvorson, *Case Studies on Pupil Response to Experimental Pricing of Milk, Madison and Milwaukee Schools,* Wis. Agr. Expt. Sta. Res. Bul. 190, Jan. 1956.

vious participation in the special milk program, regardless of experimental price reductions:

Previous level of participation	Increase in consumption	
	Madison	Milwaukee
	Per cent	Per cent
Low	104.7	58.7
Average	99.2	25.6
High	16.3	11.1

Although it was possible to measure the effect of improved availability and of previous participation rates in the controlled experiment, it was not possible in that short span of time to measure how much of the increase in consumption would be lost over a longer period.

At the beginning of the 1955-56 school year the price reductions of the previous year were maintained in many schools and a substantial group of schools made further price reductions of more than one cent per half pint. (These were possible partly because of program changes which meant more milk subsidy and more certainty as to the amount that would be received by individual schools.) These changes furnished an opportunity to measure pupil response in large numbers of schools throughout the state over a period of a year, and to compare them with the previous year. The State School Lunch Administrator, Gordon Gunderson, who had coordinated and administered the experiment, furnished program records for this further analysis.[2] Individual school records gave such information as cost to the child per half pint, estimated number of children consuming milk daily, number of days milk was served during the month, and total number of half pints served by month. The reports, however, did not show whether availability was improved by such devices as dispensers or offering bottled milk more frequently during the day, nor did they show whether the school had refrigerators, gave milk breaks, or in any way tried to promote consumption other than by reducing the prices.

The schools were grouped into two major classifications: those operating under the Special School Milk Program only, which shall be referred to as "milk-only schools"; and those participating in the National School Lunch Program or in a combination of the two programs, which shall be referred to as "milk-and-lunch schools."

Between the two school years there was a great increase in the number of participating schools, in the amount consumed and in the average number of participating children, especially in the milk-only schools

[2] Graduate students who helped to analyze the data were Leonardo A. Paulino, Donald Turner, and Ivan Hanson.

TABLE 1. SCHOOLS AND PUPILS PARTICIPATING IN VARIOUS SCHOOL MILK PROGRAMS, AND AMOUNTS OF MILK CONSUMED, WISCONSIN, 1954–55 AND 1955–56 SCHOOL YEARS

Item	1954–55	1955–56	Percentage Increase
Number of participating schools	1,989	3,192	60.5
Milk-only schools	749	1,741	132.4
Milk-and-lunch schools	1,240	1,451	17.0
Average number of days milk served			
Milk-only schools	136	173	27.2
Milk-and-lunch schools	149	174	16.8
Amount of milk consumed (1,000 quarts)	8,500	14,874	74.9
Milk-only schools	1,250	3,821	205.7
Milk-and-lunch schools	7,250	11,053	52.4
Average daily number of participating children[a]	197,900	265,000	33.9
Milk-only schools	36,400	85,600	135.2
Milk-and-lunch schools	161,500	179,400	11.1

[a] Sum of the yearly averages, for all participating schools, of the daily numbers of children consuming milk.

(Table 1). This no doubt was related to the increased size and certainty of subsidies which permitted substantial reductions in prices to pupils.

For the milk-only schools a reasonably smooth inverse relationship was found between milk price to the child and the average daily consumption per participant (Table 2). Consumption was about 40 per cent higher in schools with the lowest cost range than in the highest. The

TABLE 2. AVERAGE DAILY SCHOOL MILK CONSUMPTION PER PARTICIPATING CHILD AND PUPIL PARTICIPATION RATE, WISCONSIN SCHOOLS, 1955–56

Range of Price to Child	Milk-only Schools			Milk-and-lunch Schools		
	Number of Schools	Daily Consumption per Participating Child	Participation Rate[a]	Number of Schools	Daily Consumption per Participating Child	Participation Rate[a]
Cents per half pint		*Half pints*	*Per cent*		*Half pints*	*Per cent*
0.0–0.9	620	1.45	100.0	714	1.96	83.5
1.0–1.9	280	1.39	95.3	518	1.81	72.3
2.0–2.9	797	1.30	92.7	197	2.04	52.5
3.0–3.9	42	1.06	79.3	6	1.82	77.1
4.0–4.9				7	1.44	71.9
5.0–5.9	—[b]	—[b]	—[b]	9	1.27	75.4
All schools	1,741	1.36	95.3	1,451	1.92	74.6

[a] Participation rate is the per cent of pupils in schools within the program who consumed milk in school.
[b] Two schools.

participation rate (percentage of children consuming milk) likewise tended to increase rather substantially with cost decreases. In the milk-and-lunch schools the decision to buy milk may have been influenced by whether lunch was purchased. Consumption tended to be higher in milk-and-lunch schools than in milk-only schools, but participation rates tended to be lower.

On the assumption that most price reductions were made in the 1954-55 year, schools were classified by prices charged in 1955-56 and comparisons were made of the consumption per participating child and of participation rates in the two years (Table 3). This assumption appeared reasonable since in the three-fifths of the schools that could be matched the price reduction was nominal between the first and second year, indicating that the price reduction had been made chiefly during the first year of the school milk program.

The response to price was persistent over the two year period both in terms of consumption per child per day and in terms of participation rates associated with price (Table 3). For the milk-only schools the response measured in both terms was nearly the same the second year as the first. Though more difficult to interpret, the milk-and-lunch school data suggest that any change was in the direction of some net increase in consumption.

Seasonally, there was a steady increase in amounts of milk consumed by month up to February or March and a decline thereafter (Table 4). (Most schools are not in session in August or June; holidays affect December data.) Lack of refrigeration in many schools affects consumption during the warmer months, and also outdoor play periods reduce time available for milk drinking.

TABLE 3. COMPARISON OF AVERAGE CONSUMPTION RATE PER CHILD PER DAY AND OF PARTICIPATION RATES ASSOCIATED WITH PRICES BETWEEN TWO SCHOOL YEARS, WISCONSIN, 1954–55 AND 1955–56

Price to Child per Half Pint	Milk-only Schools		Milk-and-lunch Schools	
	Percentage Change in Average Daily Consumption per Child	Difference in Participation Rate, 1954–55 to 1955–56	Percentage Change in Average Daily Consumption per Child	Difference in Participation Rate, 1954–55 to 1955–56
Cents	*Per cent*	*Per cent*	*Per cent*	*Per cent*
0.0–0.9	−0.6	0.0	8.3	− 8.3
1.0–1.9	6.2	−4.7	9.0	− 9.1
2.0–2.9	0.0	−2.0	35.1	−21.8
3.0–3.9	−5.4	7.7	56.9	15.5
All schools	1.5	−0.2	20.8	− 5.6

TABLE 4. PERCENTAGE DISTRIBUTION OF THE AMOUNT OF MILK CONSUMED DURING THE YEAR, BY MONTH, IN THE MILK-ONLY AND MILK-AND-LUNCH SCHOOLS, WISCONSIN, 1955–56[a]

Month	Amount of Milk Consumed During the Year	
	Milk-only Schools	Milk-and-lunch Schools
	Per cent	*Per cent*
August	0.01	0.03
September	5.36	8.17
October	11.43	12.41
November	11.44	11.08
December	9.49	9.28
January	13.41	12.66
February	13.58	12.83
March	13.08	11.65
April	12.65	11.08
May	9.36	10.10
June	0.19	0.71
Total	100.00	100.00

[a] Based on all schools in the program at any time during the school year. Since a few schools were late in entering the 1955–56 program this may cause a slight downward bias in the first four months.

As would be expected, the elementary schools showed higher consumption per participating child and higher rates of participation than high schools (Table 5). Parents take a more direct part in the decisions to buy milk for the smaller children than for high school pupils. Also,

TABLE 5. AVERAGE DAILY CONSUMPTION PER PARTICIPATING CHILD AND PROGRAM PARTICIPATION RATE IN ELEMENTARY AND HIGH SCHOOLS OF THE MILK-ONLY AND MILK-AND-LUNCH SCHOOLS, WISCONSIN, 1955–56

Group and Type of Schools	Number of Schools[a]	Average Daily Consumption per Participating Child	Participation Rate
		Half pints	*Per cent*
Milk-only schools:	1,741	1.36	95.3
Elementary	419	1.22	91.3
High	39	1.08	53.4
Milk-and-lunch schools:	1,451	1.92	74.6
Elementary	957	2.01	79.3
High	225	1.73	58.1

[a] Records did not always show whether school was elementary or high; consequently the difference between the sum of elementary and high schools and total schools for each group represents a group of undefined schools which are included in upper line of each group. This also explains why, for "milk-only," combined average in columns 3 and 4 is higher than for either component.

older children may tend to feel they have grown away from milk. (No significant difference in average prices was shown as among these groups and types of schools.)

Matched Schools

Annual average change: The data showed that 554 of the 749 milk-only schools participating in the 1954-55 school year likewise were in the same program the following year. These 554 schools afforded an opportunity to "match" schools and measure the effects of price changes on milk consumption and participation rates with greater assurance that pupil group composition and other factors were more nearly identical in the two years.

The group of matched schools probably had made their major price reduction during the first program year and thus had experienced most

TABLE 6. AVERAGE CHANGES IN DAILY MILK CONSUMPTION PER PARTICIPATING CHILD AND RATE OF PUPIL PARTICIPATION ASSOCIATED WITH PRICE CHANGES IN 554 MATCHED MILK-ONLY SCHOOLS PARTICIPATING IN 1954–55 AND 1955–56

Price Change, 1954–55 to 1955–56	Number of Schools	Average Change in Daily Consumption per Participating Child	Average Change in Rate of Pupil Participation
Cents per half pint		*Half pints*	*Per cent*
Price reduction:			
3.0 and above...	15	0.15	8.77
2.0–2.9.........	68	−0.09	8.47
1.0–1.9.........	55	−0.03	7.52
0.0–0.9.........	369	−0.09	5.22
Price increase:			
0.1 and above...	47	−0.10	1.17

of the potential response of consumption to lowered prices and improved availability. Changes in average prices, consumption and participation from the first to the second program year may be modestly indicative of the elasticity of response at relatively low prices. At initial relatively low prices, further price reductions in particular schools brought negligible changes in consumption per participating child, and no actual net increase except when the average reduction was 3.0 or more cents. It seems likely that some of the response of the first year's price reduction was in process of being lost, but the additional price reductions the second year were partially offsetting this tendency. The major response, however, was the continued increase in rate of pupil participation. Even schools making modest price increases during the second program year

showed slightly higher participation rates. But again, for schools matched by months in the two years, the larger the price reduction, the greater the increase in pupil participation (Table 6).

When total monthly consumption per school in 1955-56 was compared with data for the same school and same month for the year before, the data showed consumption increases at nearly all levels of price reduction for each month until March (during which month milk was served one or two days less than during March the year before). For April and May there was no relation between the relative price reduction and total school consumption. Though consumption was declining seasonally, it averaged higher for all price brackets combined than for April and May the previous year.

Conclusions

This analysis of pupil response to price reductions in large numbers of schools throughout Wisconsin over a two-year period showed that:

(1) School children may be expected to buy about 40 per cent more penny milk than they will buy of three-cent milk, and perhaps 10 to 20 per cent more pupils will buy milk at the lower than at the higher price, when the decision to buy milk is not coupled with the decision to buy lunch (Table 2). At price levels in between these extremes the response is roughly proportionate. Price response (both in terms of consumption per participating child and number of participants) was much less in the aggregate than under those experimental conditions where availability was improved and refrigeration was good.

(2) The seasonal pattern of consumption throughout the year tends to emphasize the importance of availability and refrigeration (Table 4).

(3) Over the two year span, the initial responses to lowered prices were largely maintained as measured both by consumption per participant and by participation rates (Tables 3 and 6). Within matched schools as between the two years, the changes in consumption per participating child associated with price reductions was negligible (in fact, response did not become positive until price was reduced as much as three cents). This is further evidence of persistency because the major price reduction had been made in most schools during the first of the two years (Table 6). However, participation rates increased substantially.

(4) In the matched schools, consumption was greater for each month of the second year (1955-56) than for the same month a year earlier, up to March. This was true at each level of price reduction, but the increase tended to be greater where the reduction was as much as three cents per half pint.

PROBLEMS OF RESPONSE BIAS IN COLLECTING MILK CONSUMPTION DATA FROM SCHOOL CHILDREN[1]

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METHODOLOGY was designed to evaluate certain aspects of response bias in collecting milk consumption data from children in a sample of public schools in the Northeast region, grades 5 through 9. The sample consisted of 100 schools, 50 participating in the Special Milk Program and 50 having a milk service of their own. Selection of the 50 schools with their own milk service was on a random basis in each State in the Northeast, that is, each such school had an equal chance of being selected.[2] The 50 schools in the Special Milk Program were selected to match the nonparticipating schools as closely as possible in terms of geographic location, urban-suburban characteristics, economic level of community served by school, size of enrollment, grades taught, food service available and participation in the National School Lunch Program.

In sample schools, pupils in grades 5 through 9 in selected classes were interviewed to measure their consumption of beverages, other than water, and selected fresh fruits during the most recent 24-hour period. Self-administered questionnaires were filled out in each classroom under the supervision of a trained interviewer. A series of questions covering the entire 24-hour period was asked each child about beverages and fruits consumed. From the two sample groups, 8,444 completed questionnaires were obtained, of which 4,095 were from children attending schools participating in the Special Milk Program and 4,349 were completed by children enrolled in schools having milk service but not participating in the program.

Milk consumption in school and away from school were recorded separately. To check the quantity of milk consumed in school as recorded by recall, an audit was made of milk purchased by children in grades 5 through 9 in each of the sample schools. Sales of whole milk at school to children in the sample classes during the interview period were determined by actual count.

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[1] This article was developed out of a larger-scale research project: Milk Consumption by Children at School and at Home in Relation to Special Milk Program, which is being published as a U. S. Department of Agriculture Research Report. Data for the beverage study were collected and tabulated by Stewart, Dougall and Associates, Inc., under contract with the U. S. Department of Agriculture. The collection of data was made in the spring of 1959.

[2] The States of Vermont and Delaware and the District of Columbia did not have any eligible schools with their own milk service.

Subject Matter and Response Bias

In designing the questionnaire and conducting the interview, extreme care was exercised to avoid wording which would introduce response bias. The usual school procedure of children answering written questions under supervision of an adult and the familiar environment of the classroom were also expected to be helpful in mitigating response bias in reporting the consumption of beverages and selected fruits. In contrast, there was some concern that the subject matter, namely fluid whole milk, might tend to encourage overstatement of its consumption, since children are often told that milk drinking is basic for good physical development.

To minimize the appearance of major interest in milk, a schedule was established so that one third of the children in each sample group were queried first about their consumption of whole milk and milk products, one third first about their intake of other beverages, and one third first

TABLE 1. COMPARATIVE PER CAPITA QUANTITIES OF BEVERAGES AND SELECTED FRUITS CONSUMED BY CHILDREN, IN GRADES 5 THROUGH 9, IN THE NORTHEAST REGION DURING A 24-HOUR PERIOD BY ORDER OF QUESTION ARRANGEMENT[1]

Items	Average Consumption per Pupil by Order of Questions in Schedule		
	Fresh Fruit First	Other Beverages First	Milk and Milk Products First
	Ounces	*Ounces*	*Ounces*
Milk items:			
White whole milk	22.45	21.90	22.04
Flavored whole milk	2.03	2.23	2.12
Buttermilk	.28	.26	.13
White skim milk	.92	.90	.82
Flavored skim milk	.13	.09	.10
Cocoa or hot chocolate	1.89	1.93	1.63
Milk shake or malted milk	1.05	.89	.69
Other beverages:			
Orange juice	3.95	3.89	3.44
Other fruit juices	2.08	2.07	1.65
Tomato juice	.92	.86	.77
Other vegetable juices	.26	.28	.15
Soft drinks	6.47	7.00	6.00
Tea	1.71	1.77	1.61
Coffee	1.95	1.78	1.61
	Number	*Number*	*Number*
Fruit:			
Apple	.52	.49	.52
Orange	.36	.37	.36
Banana	.42	.38	.37
Fresh pear	.07	.07	.07

[1] Excludes children absent on day previous to enumeration.

about the consumption of selected fruits. Inclusion of questions pertaining to fresh fruit was a further attempt to disguise the questionnaire schedule by deemphasizing the role of milk. The data were tabulated by the order in which the questions were first presented to each one third of the children in the sample groups (table 1). Statistical tests revealed that the order of arrangement of items in their presentation to respondents did not generate a statistically significant difference in the reported level of milk consumption or of consumption of other major beverage items.[3]

Measurement of Response Bias Using Recall Versus Audit Techniques

Accuracy of data obtained by recall has been the subject of much debate, revolving around the respondents' overreporting the use or purchase of an item, particularly prestige items. Another point of debate centers on the memory lapse by respondents as to use or purchase of infrequently used items. In planning the study, much thought was devoted to selecting a method for collecting the data. Costs, ease with which the mechanics of the interview process could be administered in the classroom, and possible response error were weighed in reaching a decision. The recall method, limited to the most recent 24 hours, was thought to meet best the criteria used for selecting a method. An audit

TABLE 2. AUDITED AND RECALLED QUANTITIES OF WHOLE MILK CONSUMED BY CHILDREN ATTENDING SPECIAL MILK PROGRAM AND NONPROGRAM SCHOOLS, IN GRADES 5 THROUGH 9, IN THE NORTHEAST REGION[1]

Item	Special Milk Program Schools			Nonprogram Schools with Own Milk Service		
	Audit	Recall	Difference	Audit	Recall	Differenc
	Ounces	*Ounces*	*Percent*	*Ounces*	*Ounces*	*Percent*
Total	21,116	21,787	3.0	16,224	17,892	10.0
Income groups:						
High	6,928	7,081	2.0	6,368	6,775	6.0
Medium	11,812	12,117	3.0	8,352	9,153	10.0
Low	2,376	2,589	9.0	1,504	1,964	30.0
Lunch service:[2]						
Plate lunch with milk	15,284	15,615	2.0	12,800	13,635	7.0

[1] Excludes children absent on day previous to enumeration.
[2] The number of observations for plate lunch and a la carte with milk, a la carte only with milk, and milk service only were too limited to permit analysis.

[3] There was no statistically significant difference at the 5 percent confidence level in the per capita intake of whole milk.

of in-school milk purchases made it possible to check the accuracy of the aggregate quantity of milk reported consumed in school by the recall method.

Consumption of whole milk in schools as recalled by the children and that measured through an audit of school milk purchases revealed some interesting differences between the two groups of sample schools as well as among various demographic groups. For those children attending schools participating in the Special Milk Program, consumption of whole milk in school as recalled exceeded that measured by audit by 3 percent. Among children in schools having their own milk service, consumption of milk as recalled exceeded that measured by audit by 10 percent (table 2). The recall and audit were given the same careful attention and control in both groups of sample schools. The larger difference between the two measures in schools with their own milk service might be attributed to a lower incidence of milk drinking in such schools.[4] About 47 percent of the children in schools having their own milk service reported consuming whole milk at school during the 24-hour recall period, compared with 58 percent of the children in schools participating in the Federal program. Where milk drinking is widespread, less expensive, and more taken for granted, there is probably less feeling of prestige involved and thus less likelihood to overstate the quantities of milk consumed.[5]

Income level of a community appeared to have a strong influence on the difference in whole milk consumed as reported by recall and that found by audit. As the level of family income decreased the disparity between the quantity of milk reported being consumed in school and that shown as consumed by audit increased.[6] In high-income areas where the schools were participating in the Special Milk Program, the difference between quantities recalled as having been consumed in school and that audited was 2 percent compared with 9 percent in schools serving low-income areas. In nonparticipating schools, the corresponding differences were 6 percent and 30 percent, respectively.[7]

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[4] Any milk a child brought from home or purchased outside the school supply and consumed during the school hours was excluded in the comparison between quantities of milk recorded as having been drunk at school and that shown by an audit of purchases of milk at school.

[5] Children attending schools participating in the Special Milk Program paid an average of 3.9 cents a half-pint (the usual serving unit) for whole milk; those in other schools, 7.6 cents.

[6] Annual family incomes of $2,999 and under were defined as low; $3,000 to $4,999 as medium, and $5,000 and over as high. The income of the area served by each sample school was estimated by local school officials from available records.

[7] The response bias found among school children reporting the use or consumption of an item might differ greatly from that found among an older population group. Furthermore, recalling milk consumed at school might be an easier task resulting in greater reliability than recalling items consumed in the home.

The tendency to minimize overreporting where in-school milk consumption is high is reflected in type of lunch service. In program and nonprogram schools offering a plate lunch at noon, differences between recalled and audited milk consumption in school were small, 2 percent and 7 percent, respectively (table 2). Differences between the two measures, recall and audit, were still smaller in schools offering both plate lunches and a la carte service, although the number of such observations in the sample was limited. In contrast, the difference between recall and audit data in schools offering milk only was considerably larger than in schools offering both a milk and a food service.

Conclusions

Any bias that the order of presentation of a subject matter may generate in a respondent when recalling an action may be minimized or even eliminated if proper control is exercised in designing and conducting the research. In general, differences in quantities of whole milk consumed in school as measured by recall and audit were not far apart. The disparity between the two measures tended to increase sharply, however, when groups in the lower economic levels were stratified for comparative purposes. From a methodological standpoint, the analysis highlighted the problem of dealing with certain strata of population in collecting primary data, particularly for fluid milk, regardless of the technique employed.

The practicality of mass interviewing of school children on a large scale with use of self-administered questionnaires was borne out by this research effort. The mass interviewing technique was an effective mechanism for obtaining desired information with relative ease and at a low cost per interview. In most instances, school administrators viewed the experiment as an educational opportunity not ordinarily included in the usual school activities. That is, the children participated in an experiment heretofore confined primarily to the adult population.

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REVIEWS

Economics for Agriculture. Selected Writings of John D. Black, James Pierce Cavin, Editor. Cambridge: Harvard University Press, 1959. Pp. xi, 719. $12.00.

In many ways this is a unique book. That as a literary project it survived more than a decade of programming and drafting by 15 participating authors pays tribute to the intellectual community that inspires the members of the group, to their eminently worthy project, and last but not least, to the devotion of the editor.

The volume appeared on November 27, 1959, as a *Festschrift* in honor of John D. Black, one of America's great academic pioneers in the economics of agriculture and agricultural policy and a man of international renown, who lived to see it published but closed his eyes forever only a few months later, on April 12, 1960. As a testimonial volume it is original, dignified, and fortunate in content and form. Its basic substance are 24 writings by the honored scholar, selected by former students and followers of his. These are essays, articles, testimonies before Congressional Committees, addresses, and reviews stretching over a period of 34 years, organized by subject matter, not chronology.

These select pieces from the prolific pen of John D. Black are organized under twelve major subjects which form a fairly complete array of essential issues pertinent to agricultural economics and policy. Each subject has an introduction by one, or teams of two, of the fourteen contributing authors, who represent a well-known core of the numerous followers of Professor Black: Kenneth L. Bachman, Murray R. Benedict, Ray G. Bressler, James Pierce Cavin, Willard W. Cochrane, William A. Duerr, Charles M. Hardin, Sherman E. Johnson, David L. McFarlane, Theodore Norman, Oris V. Wells, Bennett S. White, Jr., and Walter W. Wilcox. These introductions range from 1 to 27 pages. Several of them are original essays in their own right. Some give a condensed historical survey on the progress in specific research areas.

This main part of the volume is preceded by a masterful portrait by one of this country's most articulate economists, John Kenneth Galbraith, of Harvard University, a former student, research assistant, and colleague of Professor Black. This biography and literary portrait brings to life and puts into proper perspective the rare combination of personal qualities that led Professor Black to break new paths into what was still largely unknown territory and to make agricultural economic history in university classes and seminars by transmitting his thoughts and interpretation

of problems and facts to his students, who gradually became more and more influential. This great portrait in some ways gives counterpoise to the selected writings in the book by showing convincingly that John D. Black was first and last of all a uniquely gifted, challenging and influential academic teacher who never hesitated to make his students work up to and beyond capacity according to the same standards of work he applied to himself.

As a pioneer in research in the social sciences Professor Black had, in Galbraith's words, "a superb sense for what isn't known," and a sense of relevance and a complete disregard for the difficulties involved in tackling research problems. This speculative sense of where to explore and the optimistic determination to attack the problem are, of course, the qualities which distinguish the pioneer in research in any discipline.

The reader follows the career from the initial phase of 1918-1927 at the University of Minnesota, through the years beginning in 1928 at Harvard University, where he taught for close to a generation and drew gifted students from all parts of the United States and many foreign countries.

While this book concerns the work and life of a university professor and scholar, it has simultaneously the flavor of the memoirs of statesmen. The professional career of Professor Black began with the inflation during and after the end of World War I. He participated actively in discussion and shaping of policies which began as farm relief but led gradually to more comprehensive economic programs for agriculture, not only those of farm tenure and farm credit, but also those of more government planning, direction, and action in the production and marketing of farm products, and providing income support for the farm population. In absorbing Mr. Galbraith's portrait and action-abounding curriculum of John Black, the reader follows a conducted tour through four decades of the history of agricultural policy in the United States and sees the whole galaxy of prominent scholars, administrators, and researchers pass the stage.

Similarly, the selected writings and their introduction deal with a majority of major economic problems concerning agriculture or problems of economic research concerning agriculture, with shifting historical emphasis as four dramatic decades pass by. Among the writings, one of the most penetrating and live pieces, introduced by Bennett S. White, Jr., is the main part of Professor Black's presidential address of December 1955 before the American Economic Association, "Agriculture in the Nation's Economy." In this commanding survey written at the summit of his influence and mastery of his subject, the author measured the dynamic changes of American agriculture for the period 1910-1955, followed by a

projection up to 1975, along with consideration of welfare aspects, and problems, policies, and programs.

While space forbids passing the introductory essays in critical review, this reviewer found the introductions by Sherman E. Johnson and Kenneth L. Bachman, Murray R. Benedict, James Pierce Cavin, Willard W. Cochrane, and Walter W. Wilcox particularly instructive, each in a different way. But there are several others also of merit.

In summary, this is a well-executed, cooperative enterprise by representatives of a most influential school of thought honoring its founder and head, and a book that no one interested in economic policy issues of American agriculture can afford to ignore: the less so the more he may disagree in matters of policy. While the subject is economics, the volume is pervaded by a powerful epic quality which is partly due to the dynamic personality of John D. Black, but partly the blend of action of teacher, director, stimulator, and pilot of research, adviser of legislators, and consultant of government executives.

A well-organized bibliography of the writings of John D. Black rounds out the volume.

KARL BRANDT

Council of Economic Advisers

Agriculture and Urban Growth (A Study of the Competition for Rural Land), G. P. Wibberley. London: Michael Joseph Ltd., 1959. pp. 240. 21s. net.

The increasing concern of many over the rapid shifting of agricultural land into urban, industrial, highway and other nonfarm uses, makes most timely Dr. G. P. Wibberley's new book on urban competition for rural land. The author, head of the Department of Economics of Wye College, University of London, gives all those concerned with this changing pattern of land use a basis for logical thinking.

He reviews both the present pattern of land use in Britain and the anticipated withdrawal of land for urban growth. Most of the increase in urban land is expected to come from good agricultural land now being used for dairying, market gardening and cash crop production. He sees agriculture outbid by urban development and forced to take what remains when free competition prevails. At the same time, he recognizes the problem of effective planning when price is not allowed to be the sole arbiter.

Under the Town and Country Planning Act of 1947, planning committees are required to give consideration to the case for agriculture when a major change in use is contemplated, with the burden resting upon those

wishing to initiate the change. Although definite procedures have been established for determining the value of the land involved, the author feels that the methods used are not too satisfactory. The only basis for a negative answer to a proposed change is to locate within the area another piece of less valuable land that can be developed for the nonfarm use at a minimum of added cost. Recognizing the weakness in this procedure, Dr. Wibberley outlines a method based on the opportunity cost in which the interests of society as a whole are considered. The operation of the approach is effectively demonstrated by the use of specific cases involving both small areas in which only parts of farms were involved and in larger areas where many farms were included.

Wibberley examines in detail the possibility of food replacement at home and abroad. He reviews the case for increased imports and concludes that Britain must continue to secure the same proportion of its food needs from domestic sources as at present.

Gardening (a traditional activity of the British) on the land transferred to urban development is carefully investigated and dismissed as offering no significant replacement opportunity in view of the changing personal habits accompanying the rising level of living. The opportunities for increasing food production by bringing new crop land into use and for raising the output from existing crop and pasture land by land improvement and greater intensity are explored for both the uplands and the lowlands.

Capital costs of replacing the food lost per urbanized acre are computed for each opportunity and the returns on capital compared. Food replacement in the lowlands through reclamation of coastal areas and derelict woodland and general intensification of production on existing land were found to require the least capital and to yield the best return. Improvement of farms in the uplands was found to involve a much higher capital investment per acre lost to urban usage.

On the basis of his analysis of food replacement opportunities and the capital investment needed per acre lost to urban growth, Dr. Wibberley concludes that "there can be too much worrying about the difficulties and dangers of losing large areas of agricultural land to non-agricultural purposes." In his opinion, more attention needs to be given to the constructive side of the rural-urban land competition. He suggests that in most countries there are replacement opportunities that can be used on the remaining rural land to relieve the pressures as the competition from nonagricultural uses increases.

The author gives an excellent appraisal of the problems of urban competition for rural land. He provides the reader with workable methods for measuring the worth of land under consideration for nonfarm use and

for determining the possibilities and costs for replacements. The book is well organized and is illustrated and supported by extensive research, much of which was conducted under the guidance of Dr. Wibberley. It is adequately but not overly documented with statistics. Simple economic concepts are effectually used, making it readily understandable to the layman as well as to the student of economics.

This book, a welcome addition to the literature in land economics, has wide applicability although it deals specifically with the problem in Britain. It provides excellent supplemental reading for courses in land economics and should have high priority on the reading list of all who are concerned with our rapidly changing land use pattern.

JOHN H. SITTERLEY

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The Welfare State in New Zealand, John B. Condliffe. London: Ruskin House, George Allen and Unwin, Ltd., 1959. Pp. 396. 30s.

Perhaps a legitimate question might be raised as to why *this* title is being reviewed for the audience of *this* Journal. There is a natural answer: Welfare in New Zealand is almost synonymous with conditions and the state of affairs surrounding agriculture. In answering such a question in *this* way it matters little either as to the nature and level of welfare or the type of agriculture. All those agricultural economists who are interested in policy matters might do well to ponder long over the New Zealand experience.

The central question about this book, and one of real significance for our profession, involves the impact on national welfare of decisions made by officials within a predominantly agricultural orientation. New Zealand might be called a special example, but what is "normal" when we talk about the relationship between agriculture and national welfare?

Condliffe is in a good position to analyze this central question with respect to the New Zealand laboratory. His book is a classic from the standpoint of analyzing the hopes, the ambitions, and the pitfalls of governmental interference in a national economy, in light of the changing relationships in a world bent on nationalism and the frailties of human personality and organization. Born and reared a New Zealander, an outstanding economic analyst, and a recognized authority on international affairs, the author is in a position to interpret for us the experiments conducted in his native land. This he does with clarity and insight as he did in *New Zealand in the Making,* which since its first publication in 1930 has been used widely as an economic history of that country.

The present book is a treatment of events since World War I which will interest not only the agricultural policy maker, but also the wage

theorist, the welfare economist, the international trade expert, those interested in economic development, and many others in the field of economic analysis. It is divided into eight chapters as follows: The Impact of Depression, Planned Insulation, The Structure of the Economy, Borrowing for Development, The Economic Functions of Government, State Regulation of Wages, The Social Welfare State, and New Zealand in the World.

The author is a master of the historical critique. Details of New Zealand's experience with the Meat Export Control Act, the Dairy Produce Export Control Board, the Primary Products Marketing Act, the Wool Disposal Commission, and many other organizations are recorded in such fashion as to make the United States agricultural economist feel at home because of our own experiences in these areas. The New Zealand farmer and farm organization, however, were delegated far more power than their American counterparts, and the rigidities inherent in such power placed great difficulties in the way of adjustments to fluctuations in world markets.

When New Zealand's Labor Party assumed power in 1935, its program was built around a plan to insulate the national economy from external fluctuations in the export markets. On the basis of a stabilized national income, the stated policy was to achieve simultaneously three major objectives—stability of domestic prices, social security and income redistribution, and national development. A major portion of Condliffe's narrative is devoted to questioning the economic policy of the New Zealand government from the date the Labor Party came to power. The instruments of that policy come under closest scrutiny. For example, it is pointed out that the government persisted in believing in the magic of credit to achieve all economic objectives, whereas little reliance was placed on taxation. Harsh words are used to describe the author's lack of sympathy with the confused economics of the welfare era. Such terms as ". . . this pathetic and muddled belief in the power of credit . . ." (pp. 66-67) are used frequently in the book and it becomes clear quite early that the author is disappointed with the economic performance which the country has achieved in the welfare state. He is on firm ground when he states, "There is always a tendency for planners to underestimate the subtlety of the free market mechanisms" (p. 107).

From an analytical standpoint the author's greatest contribution is to point out the latent contradictions of a policy of national income stabilization which carries built-in guarantees against all types of economic ills and which is, at the same time, coupled with promises of gains from rising prices, full employment, etc. As a good example, New Zealand's dairy producers set out to get a price which would guarantee them a

reasonable standard of living, but failed to fully appreciate that their produce had to be sold in markets beyond the control either of themselves or their government. In short, the problem of stabilization is not easy in a country the national income of which is substantially generated by export receipts.

New Zealand's lesson is particularly valuable to the small, specialized, underdeveloped but nationalistic country of the 1960's which wants to balance an accelerated program of human welfare with a well-governed, law-abiding community filled with integrity and justice. But it is the reviewer's opinion that Condliffe has something to say to all of us in the last paragraph from which an extensive quote is given:

> The need was great for basic experimental research scientists. It was even greater, though less readily appreciated, for young men competent to analyze and measure the trends of economic happenings at home and abroad. In both areas of research, the natural sciences and human behaviour, there was a double tendency to rely upon the State and to resist the necessity of rewarding adequately, in freedom and status as much as in pay, those capable of being trained to high levels of research ability. *The bane of democracy is that equality tends to uniformity and even mediocrity. No man is better than any other or deserves more recognition. This weakness was accentuated in New Zealand by the concentration of research as well as administrative initiative in government departments.* Not only was there centralized control of expenditure so that, in effect, civil servants determined what research could be undertaken. It was all but impossible to set a scale of rewards adequate to attract and keep really first-class research workers, for fear that such rewards would start a cycle of salary increases throughout the civil service. This fear operated even in regard to the experimental sciences. It was still more potent in regard to economic studies where the results were less demonstrable and much more a matter of judgment. (Reviewer's italics.)

Lest the reader get the wrong impression either of the author or the reviewer, this is no anti-government treatise. There is no bias at large against the welfare idea as such. Condliffe presents a thorough examination of the welfare context in which an economic policy is conceived, promulgated, and harvested. His presentation of New Zealand's performance is a valuable addition to the literature.

JIMMYE HILLMAN

University of Arizona

Agricultural Marketing Policies, G. R. Allen. Oxford: Basil Blackwell, 1959. Pp. xii, 336. 42s.

This book is a collection of previously published articles integrated with additional material to cover many current issues in British agricultural marketing policy. Though the topics covered are British, the author's domain for assembling evidence to bear on them is the wide, wide

world. Thus, a minimum contribution of this book is to expose readers in this country to a wide selection of foreign marketing policies and published research findings, organized largely along commodity lines. Certainly no one will venture to suggest that the author falls prey to the deficiency he observes in U. S. agricultural marketing texts and studies—a preoccupation with domestic problems and attempts to solve them.

No book is available in this country to which Professor Allen's efforts can be directly compared. In fact, the reader is soon struck by the difference in viewpoint, if not in substance, displayed in this book and those of our home-grown variety. The author's interest is in policy; and economic theory, though used liberally, is looked upon to provide the basis for its formulation. This is a proper use of theory, but it requires that Allen's version be up to the task he sets for it.

Minimization of distribution (marketing) costs is the primary policy objective established by the author to guide government intervention in the marketing system. However, he recognizes that it may be possible to use the marketing system to control year-to-year or other short-term variations in output and prices. This may give rise to competition between stability and efficiency as competing ends in policy, which leads to the conclusion that stability should be sought mainly through ". . . the influencing of producers' expectations . . . with the determined and confident aim of sufficiently influencing farmers' production plans to insure that future demand and supply are brought more nearly into balance than would otherwise be the case."

The role of the marketing system in moderating or accentuating price and output cycles is the chief way in which the author attempts to study ". . . agricultural marketing not in isolation from the rest of the economy but . . . as a part of a complex system." More seems promised, especially in view of the author's own characterization of his book as ". . . an introduction to the application of welfare economics in agricultural marketing." Further investigation of the interdependence of the efficency of resource allocation between the production and marketing sectors would very likely raise doubts about the author's conclusion that ". . . the theory of imperfect competition has little bearing on agricultural marketing except where there are agreements to restrict competition. . . . Geographic market imperfections can be dismissed as an unimportant source of cost-raising restraints on competition." If cost-raising effects are considered in the total system for producing and distributing agricultural products, imperfections in the competitive allocation mechanism may play a more prominent part.

When marketing is considered in isolation from production, the author specifies that the general policy objective should be to promote competi-

tion. Thus, he exhibits a thoroughgoing belief in the need for free competition among a "sufficient number of independent firms" in order to increase efficiency in marketing. Two widely recognized arguments for monopoly and oligopoly, and against rigorous competition, are discussed: long-term growth of productivity through technical progress and economies of large-scale operation. The first is rejected outright on the basis that public research institutions can be expected to undertake much of the important technical research in marketing and promote its use by marketing firms. When large-scale economies are so great that there is a place ultimately for only one or a few firms if marketing costs are to be minimized, direct controls are admissible, but solutions ". . . retaining the main elements of a competitive system" are most desirable.

Generally, structural criteria are advocated as a basis for government action to ". . . eliminate restraints on competition, such as restrictions on entry of new firms and immobility of factors of production." When large firms dominate the market, countervailing power, promoted by positive public action, is indicated to insure vigorous competition.

A wide gap necessarily remains between Professor Allen's prescriptive theory of what could be and what is in the way of public policy in agricultural marketing. The width of this gap must stand as a measure of the book's success. Only to a very limited degree does the author question the adequacy of the perfectly competitive model for normative policy purposes. It is supplemented with the basic idea of countervailing power and not much else. We may agree with the author that there ". . . are situations where market forces can be made an effective and adequate rationalizer and others where they cannot," but we would like to have a better basis for prediction in specific cases. What forms of government action can best insure freedom of entry and mobility of resources, thereby thwarting restraints on competition? When large-scale economies clearly justify fewness on the marketing side, how can farmer bargaining power be increased consistent with efficiency of the overall production-distribution system and general consumer welfare? Little is found in this book to answer these and many other important questions which arise when attempting to implement policy objectives as broad and general as those established by this author.

L. B. FLETCHER

University of California

Fundamentals of Forestry Economics, William A. Duerr. New York: McGraw-Hill Book Company, 1960. Pp. xii, 579. $9.50.

The second text in forest economics to appear within the year establishes quite a milestone for this newly developing field of study. The au-

thor draws heavily upon research experience with the U. S. Forest Service as well as upon his more recent activities as Professor of Forestry Economics at the State University of New York College of Forestry at Syracuse University.

Economists will almost surely raise the question, "What special characteristics set forestry apart from other productive efforts—why forestry economics?" Professor Duerr answers this by citing five peculiarities of timber production: 1. The product, timber, is also the productive mechanism; 2. An exceptionally long production period is usually involved; 3. The rate of return on capital is modest; 4. Forestry capital (the investment in growing stock) dominates the cost of timber growing; 5. This capital is highly versatile, both production- and time-wise. He further claims (citing Vaux) that "the special field would still emerge because of the great importance of the forest industry and because of its peculiarities in respect to organization, institutions, techniques, and terminology."

After introducing his subject, Professor Duerr divides it into four parts. Under "The Firm's Supply of Forest Products" he treats principles of production theory: production functions, cost curves, short run and long run supply curves, etc. He stresses application of marginal analysis to a variety of timber production problems, including that of multiple product management. The next section, "The Market for Forest Products," covers elementary demand theory and a rather detailed treatment of timber marketing. The last two sections are called "Institutions of the Forest Economy" (tenure, taxation, credit, and insurance) and "Operation and Planning of the Forest Economy," where the discussion ranges from the world's timber resources to regional planning and its application to public forestry problems.

There is much to commend this text to those teaching economics to undergraduate forestry students. Basic principles are developed through examples drawn from the timber industry. The technical terminology employed is either that of forestry or is carefully explained. Though some might believe the production-supply aspects are overemphasized to the detriment of demand, the treatment parallels the weight accorded production by most forestry curricula. An exceptional effort is made to encourage a broad view on the part of students normally inclined to retreat from exposure to the social sciences. One device to achieve this end is that of raising questions throughout the text—questions designed to "provoke reflection and original thinking." Others might include his treatment of "centers of influence" and topics such as advertising, programming, and regional planning. The range of material covered is extremely broad.

The economist looking for a specialized treatment of forestry problems

will be disappointed by this book. Peculiarities presumed to characterize timber production are not made a focal point for theoretical development, nor is evidence presented to show that forestry is peculiarly affected by organizational, institutional, or technical factors. What Duerr has done, essentially, is to write a textbook of economics for forestry students. It is within the reference framework of such a text that the book should be judged.

A major difficulty is that the approach to principles is often indirect and unnecessarily complicated. One might also wish that a more prosaic illustration had been selected to introduce marginal costs. The varying input is in terms of men, and men are peculiarily indivisible. Perhaps more serious is the fact that in trying to keep his presentation at an almost nontechnical level (from the economist's viewpoint) some errors have been allowed to creep in. Under the *Elasticity of Demand,* for example, the author states, "It is not only the position and general orientation of the demand curve that concerns us, but also its shape and tilt. The tilt *at any point or interval* on the curve is referred to as *elasticity of demand*. . . ." He goes on to correctly define elasticity in terms of a ratio of percentage changes but nowhere corrects the implied identity of slope and elasticity.

Numerous "rules" are announced in boldface type—a geometric rule of the total, of the average, etc.; first and second rules for price elasticity; a rule for best combination; and many others. Such rules may aid a student's memory, but tend to detract from the principle being discussed. And, though the author's effort to jar forestry students into an awareness of the role of power blocs in modern society is sincere and much appreciated, one might question whether a text of this type should present an individualistic viewpoint of issues.

To conclude: This book is a major contribution to forestry, presenting economic principles in a form particularly suited to forestry students. The illustrations and examples are well designed to hold their interest. Many forestry-school teachers have been looking for just this kind of text. It should have an excellent reception.

G. R. GREGORY

The University of Michigan

Introduction to Mathematical Statistics, Robert V. Hogg and Allen T. Craig. New York: The Macmillan Company, 1959. Pp. lx, 245. $6.75.

This is an excellent book, consistent in content and development with intended usage at the senior or beginning graduate level for majors in statistics. It is a theory book about mathematical statistics and provides few bridges for specific applications.

The introductory chapter is outstanding—developing the essential probability base from a consideration of the algebra of sets and set functions. Three chapters are devoted to special distributions, stochastic independence, and transformations of random variables. The subject of parameter estimation, with major emphasis on point estimation in contrast with the interval estimation coverage, is developed in two chapters. Chapters 7 and 8 are devoted to a consideration of some limiting distributions (when the sample size, n, is considered a parameter) and nonparametric problems. The topic of statistical hypothesis testing is given careful, but restricted, consideration. Two terminal chapters are devoted to quadratic forms and an introduction to multivariate distributions.

Merely listing the subject matter coverage fails to give justice to the excellent treatment. Some praiseworthy features are: (1) The preferred, standardized symbolism and definitions for statistical writing are employed. (2) Full details of solutions are given—a must for easy understanding. (3) Continuous, dual developments for the discrete and continuous cases are presented. (4) Order statistics are blended into discussions of general distribution theory topics throughout the book. (5) References to sources of theorems in measure theory and advanced calculus that are employed without proof provide completeness and should elicit student curiosity for further study. (6) Throughout the book comments are carried directly in the text, in contrasting print, rather than in footnotes.

Some indication of the lucid and well-integrated development of the book can be gathered from the experience of this reviewer. My theoretical background in mathematics and advanced mathematical statistics has been neither extensive nor very penetrating. Nevertheless, in only a few sections was I unable to read the material continuously and without delay while securing understanding. This should be an index of its value to a student for study outside class.

Very few good things are completely flawless, and so it is with this book. Much argument could be made for inclusion of some omitted topics, but this would be of limited value for a book at this level since most of the essentials are covered. Consequently, my adverse criticism will be directed at technical points about topics that are included. They are as follows: (1) The discussion of a closed interval estimate of the mean of a normal distribution with known variance (p. 58) should have been extended to cover shortest length and the association with sample size, n. (2) On pages 60-61, the discussion on interval estimation of σ^2 implies that the solution for shortest length is not available. An extension could have covered the significance of seeking the shortest interval in lieu of the conventional as a function of n, and the confidence coefficient.

The solution for shortest length is no more difficult than other topics in the book. (3) There is a rather general failure to link together the parametric areas of interval estimation and testing of hypotheses. This detracts from theoretical unity.

To minimize the relative significance of the adverse remarks given above, I must restate that this is an excellent textbook. It is nearly free of typographical errors (only one was noticed) and is written so as to maximize its usefulness for students.

J. B. HASSLER

University of Nebraska

NEWS NOTES

F. GENE ACUFF has received a summer appointment as Research Assistant at Kansas State University to work with Professor R. E. Dakin on a watershed project.

GEORGE ALLEN, formerly with the Marketing Economics Research Division, AMS, is now with the American Meat Institute in Chicago, Ill.

JOHN W. ALLEN completed an assignment as Instructor in Food Distribution at Cornell in June. He will resume graduate studies in the Fall and will do part-time research at the School of Business and Public Administration.

GORDON ANDERSON has been promoted to Assistant Professor in the Department of Agricultural Economics at the University of Manitoba.

A. J. ASHE accepted a position as Economist and Manager of the Business Research Department of the B. F. Goodrich Company, effective June 1. His headquarters are in Akron, Ohio.

EMERSON M. BABB, JR., formerly an economist for the Eastern Milk Producers Cooperative Association, Syracuse, New York, has joined the staff of the Department of Agricultural Economics at Purdue as a marketing economist.

ROY BALLINGER has joined the Marketing Economics Research Division, AMS. He was formerly with the U. S. Cuban Sugar Association.

ALAN R. BIRD, Farm Economics Research Division, ARS, stationed in Michigan, has completed requirements for his Ph.D. degree.

MELVIN G. BLASE, Farm Economics Research Division, ARS, completed requirements for his Ph.D. degree at Iowa State University on April 29.

J. F. BOOTH retired April 1 as Director of the Economics Division of the Canada Department of Agriculture. He had directed the affairs of the Division since he first organized it in 1929. Dr. Booth has accepted an extension beyond retirement age as special advisor to the Department, with responsibility for relations with the Food and Agriculture Organization and certain other international activities.

DEWEY O. BOSTER, In Charge, Harrisburg, Pennsylvania, Office of the State Statistician, Agricultural Estimates Division, AMS, received a USDA honor award on May 17. In March he was elected President of the Harrisburg Chapter of the American Statistical Association.

DAVID BOYNE has accepted a position as Assistant Professor at Michigan State University effective January 1, 1961. He is completing his doctorate at the University of Chicago.

GARNETT L. BRADFORD was appointed instructor in the Department of Agricultural Economics at North Carolina State College in July.

ERLY BRANDAO, Professor of Agricultural Economics of the Rural University at Vicosa, Minas Gerais, Brazil, has been a visiting scholar in the Department of Agricultural Economics at Purdue University for the past semester.

CURTIS BRASCHLER, who recently completed his Ph.D. in Agricultural Economics at Purdue University, has joined the staff of the University of Missouri.

GEORGE K. BRINEGAR, University of Connecticut, will join the staff of the University of Illinois on September 1 as Professor of Agricultural Economics.

MARTIN BRONFENBRENNER and W. DAVID HOPPER are visiting professors in agricultural economics at the University of Minnesota this summer to assist

in a special seminar for foreign graduate students in agricultural economics from the Far East.

ALFRED BURNS has joined the Marketing Economics Research Division, AMS. He recently completed graduate work at Purdue University.

GORDON G. BUTLER transferred to the Washington, D.C., office of the Dairy Statistics Branch, Agricultural Estimates Division, AMS, on June 1. He was previously in charge of the Trenton, New Jersey, Office of the State Statistician.

ADGER B. CARROLL will join the staff of the Department of Agricultural Economics at North Carolina State College as Instructor in September.

BETTY A. CASE, formerly with the Farm Economics Research Division, ARS, transferred in May to the ARS Data Processing Division, Systems and Programming Branch.

ROBERT L. CLODIUS was appointed Chairman of the Department of Agricultural Economics at the University of Wisconsin on July 1.

R. L. CLODIUS and W. F. MUELLER, of the University of Wisconsin, are recipients of a $40,000 grant from the Small Business Administration and the Wisconsin Department of Resource Development to study the use of cooperative arrangements by small agricultural processing business.

C. W. CRICKMAN, Farm Economics Research Division, ARS, received a Superior Service Award at the Department of Agriculture Honor Awards Ceremony held May 17. The citation read, "For leadership in developing imaginative approaches to economic research programs on regional agricultural adjustments, requiring singular knowledge of agriculture, established research techniques, and emerging econometric concepts and procedures."

WILLIAM A. CROMARTY resigned from Michigan State University on June 30 to accept an economic research position with Connell & Company, in Westfield, New Jersey. He will be engaged in commodity analysis and will work initially on developing an econometric model for soybeans and soybean products.

R. E. DAKIN, Associate Professor in the Department of Economics and Sociology, Kansas State University, was placed on twelve-months' basis effective July 1, with half time on the staff of the Agricultural Experiment Station.

REX DALY returned from Karachi, Pakistan, on May 12. He had been on a mission for the International Cooperation Administration. He is Chief of the Farm Income Branch, Agricultural Economics Division, AMS.

WILLIAM H. DANKERS is on leave from the University of Minnesota this summer to study food marketing trends and developments in Europe and their impact on trade between the United States and Europe.

D. B. DELOACH, University of California, has transferred from the Los Angeles to the Davis campus.

FOLKE DOVRING joined the University of Illinois staff on February 1 as Professor of Agricultural Economics. He was formerly with FAO in Rome.

WILLIS G. EICHBERGER, formerly with the Farm Economics Research Division, ARS, transferred in May to the Department of Health, Education, and Welfare. He is stationed in Atlanta, Georgia.

EBER W. ELDRIDGE has been promoted to Associate Professor in the Department of Economics and Sociology at Iowa State University (Ames).

HELEN C. FARNSWORTH has been appointed Associate Director of the Food Research Institute, Stanford University.

DARRELL F. FIENUP, University of Minnesota, is on a year's leave with the AMS

in Washington, D.C., to study the impact of federal grading on the market structure and pricing of lamb.

LEHMAN B. FLETCHER has been appointed Assistant Professor of Economics and Sociology at Iowa State University (Ames), beginning July 1. He was previously at University of California, teaching at Los Angeles and completing his Ph.D. in Agricultural Economics at Berkeley.

KARL A. FOX, Professor and Head of the Department of Economics and Sociology at Iowa State University (Ames), has been granted leave of absence from September 1960 through May 1961 to serve as Visiting Professor of Economics at Harvard University. John A. Nordin will serve as Acting Head of the Department during this period.

JOHN O. GERALD, of the Marketing Economics Research Division, AMS, has transferred from the Washington office to Berkeley where he has been appointed Secretary for the Western Agricultural Economics Council.

RAYMOND W. GIESEMAN was appointed Assistant Professor in market prices at Kansas State University, effective July 1, to replace Larry Van Meir. In May he completed work for the Ph.D. at North Carolina State College.

C. B. GILLILAND, former Head of the Special Crops Section of the Marketing Economics Research Division, AMS, is now with the Product and Process Evaluation Staff, Utilization Research, ARS.

JAMES D. GOETZINGER has a summer appointment as Assistant Instructor at Kansas State University working with Associate Professor John McCoy on a project in livestock marketing.

RAY GOLDBERG is a visiting professor in agricultural economics at the University of Minnesota this summer.

GEORGE H. GOLDSBOROUGH, former head of the Merchandising Methods Section, Market Development Research Division, AMS, is now with the Product and Process Evaluation Staff, Utilization Research, ARS.

DANA C. GOODRICH, JR., Assistant Professor at Cornell University, will conduct research in marketing flowers and nursery products. He was formerly Extension Economist in poultry marketing and farm management.

ROGER W. GRAY has been appointed Professor and Economist in the Food Research Institute, Stanford University.

W. SMITH GREIG became an Associate Professor at Michigan State University on July 1.

FLOYD W. GRIFFITH transferred on May 15 from the Springfield, Illinois, Office of the State Statistician to the Washington, D.C., office, Livestock Section, Livestock and Poultry Statistics Branch, Agricultural Estimates Division, AMS.

JOSEPH HAJADA has a summer appointment as Assistant Professor at Kansas State University. He is working with Associate Professor J. A. Schnittker on a project concerned with the administration of public policy program.

LOWELL HARDIN and LEON HESSER, of Purdue, are in Japan from June to September making a Purdue–Foreign Agricultural Service market development study.

BURTON J. HARRINGTON transferred on May 22 from the Office of the State Statistician, Montgomery, Alabama, to the Washington, D.C., office, Prices Paid Section, Agricultural Price Statistics Branch, Agricultural Estimates Division, AMS.

EARL O. HEADY, Professor of Economics at Iowa State University (Ames) and

Executive Director of the Center for Agricultural and Economic Adjustment, is spending October 1960 through May 1961 at the Center for Advanced Study in the Behavioral Sciences at Stanford University conducting research on economic and agricultural adjustment.

REX D. HELFINSTINE joined the staff of the Economics Department, South Dakota State College, on April 1. He was formerly with the Farm Economics Research Division, ARS, stationed in South Dakota.

CLARENCE I. HENDRICKSON has been made Acting Head of the Special Crops Section, Marketing Economics Research Division, AMS.

J. S. HILLMAN, Professor of Agricultural Economics at the University of Arizona will be on leave during July lecturing in Santiago, Chile, at a short course on Marketing Research sponsored by the Organization of American States (Pan-American Union).

CHARLES A. HINES transferred from the Agricultural Price Statistics Branch, Agricultural Estimates Division, AMS, to the Office of the State Statistician at Madison, Wisconsin, on May 1.

HOWARD H. HINES has been promoted to Professor in the Department of Economics and Sociology at Iowa State University (Ames).

PAUL H. HOEPNER, Assistant Professor at Virginia Polytechnic Institute, received the Ph.D. at the University of Minnesota in June.

PAUL L. HOLM, formerly with the Farm Economics Research Division, ARS, transferred in May to the ARS Data Processing Division, Systems and Programming Branch.

L. D. HOWELL, Marketing Economics Research Division, AMS, recently received a Superior Service Award from the U. S. Department of Agriculture. The award was presented for "developing economic analyses related to an appraisal of the effect of changing practices and market structure upon the competitive position of cotton and wool."

O'DEAN HUBBARD has joined the staff of Oklahoma State University. Mr. Hubbard has completed the preliminary examination for the Ph.D. degree at the University of Illinois.

ROBERT E. JACOBSON is completing the requirements for the Ph.D. degree at the University of Illinois and has accepted a position as Dairy Marketing Specialist with the Federal Extension Service in Washington, D.C.

BRUCE F. JOHNSTON has been appointed Professor and Economist in the Food Research Institute, Stanford University.

G. L. JORDAN, Professor of Agricultural Economics, University of Illinois, will retire September 1.

AVTAR S. KAHLON became Temporary Instructor at Kansas State University on June 1. He is working on a grain marketing project with Professor L. W. Schruben.

LUTHER H. KELLER joined the staff of the University of Tennessee on July 1 as Assistant Professor of Agricultural Economics and Assistant Agricultural Economist, after completing his Ph.D. work at the University of Kentucky.

BRUCE W. KELLY has transferred from the Office of the State Statistician at Orlando, Florida, to Washington, D.C., to be in charge of the Research and Development Staff, Agricultural Estimates Division, AMS. He replaces W. A. Hendricks, who recently retired.

M. S. KENDRICH, of Cornell University, is spending the summer at the University of Hawaii teaching taxation and finance.

Arnold B. Larson has been appointed Acting Assistant Professor in the Food Research Institute, Stanford University.

Jerry M. Law, of Louisiana State University, is in Sapparo, Japan, conducting a Summer Institute on agricultural marketing research methods at the University of Hokkaido. Dr. Law went to Japan under the auspices of the Council on Economic and Cultural Affairs, Inc. He will return to his duties at Louisiana during the last week in August.

Elmer W. Learn and James P. Houck, Jr., of the University of Minnesota, are in Germany this summer on a contract research project with Foreign Agricultural Service, USDA. The project deals with an appraisal of market development programs conducted in West Germany under Section 104(a), PL 480.

Frank Maier, Farm Economics Research Division, ARS, is now in charge of the Division's farm labor investigations.

John G. McNeely has returned to Texas A. & M. College to resume his duties as professor. He had been on a one-year leave of absence to serve as visiting professor to Gokhale Institute, Poona, India, under the sponsorship of the Ford Foundation.

Jarvis Miller, associate professor at Texas A. & M. College, was in London and Bradford, England, during May and June studying marketing practices relating to imported meat, wool and mohair.

Leo J. Moran has resigned as Assistant Professor of Agricultural Economics at the University of Arizona to accept a position as Economist with the Stanford Research Institute at South Pasadena, California.

Joe Motheral, formerly with the Farm Economics Research Division, ARS, and for the last 2 years with the Harvard Pakistan Project in Karachi, will join the staff of the World Bank this summer.

George Motts will retire on December 31 from Michigan State University. He has spent nearly 30 years at the institution, most of the time in fruit and vegetable marketing.

Marc Nerlove has resigned as Associate Professor of Economics and Agricultural Economics at the University of Minnesota to accept appointment as Professor of Economics at Stanford University, effective September 1. He is spending the summer as a consultant with the RAND Corporation in Santa Monica, California.

Stanton P. Parry will join the staff of the University of Tennessee on September 1 as Assistant Agricultural Economist. He has been on the staff at Bethany College, Bethany, Oklahoma since 1958.

Mary Kay Peerson was appointed Research Assistant at Kansas State University on June 6. She is working with Professor R. E. Dakin on a watershed project.

Frederick A. Perkins has resigned his position as Instructor in Agricultural Economics at the University of Maine to accept a position as Assistant Professor at Rutgers University.

W. H. Pine has returned to Kansas State University after a two-month's appointment as consultant in agricultural economics to the U.S. Overseas Mission of ICA in Surinam.

Norman Rask, Farm Management Extension Specialist at Cornell, is leaving to pursue graduate work at the University of Wisconsin.

Robert B. Reese has joined the staff of the Market Development Research Division, AMS. He will head the unit responsible for research on public

programs in the Development Analysis Branch. He was formerly with the Marketing Economics Research Division.

HAROLD RILEY, Michigan State University, will leave for Colombia in August to serve for eighteen months as the University's consultant to the Agricultural College in Palmira. He was promoted to Professor on July 1.

LYNN ROBERTSON, who has been in charge of the Purdue team at the Rural University at Vicosa, Brazil, for the past two years will return to Purdue around the first of October.

ROLAND R. ROBINSON joined the Washington staff of the Farm Economics Research Division, ARS, in April. He will work on the economics of farm structures.

R. C. ROSS, Professor of Agricultural Economics, University of Illinois, will retire September 1.

JOHN R. SCHMIDT, assistant professor at the University of Wisconsin, received the Ph.D. degree at the University of Minnesota in July.

L. W. SCHRUBEN, Kansas State University, is on leave for one year as economic adviser to the Great Plains Wheat Market Development Association.

C. P. SCHUMAIER, formerly Assistant Professor at the University of Illinois, joined the staff of the Agricultural Marketing Service, USDA, on May 1.

J. T. SCOTT has been promoted to Associate Professor in the Department of Economics and Sociology at Iowa State University (Ames).

MRS. JANE BEACH SEARS was appointed Research Assistant at Kansas State University June 13 and is working with Professor R. D. McKinney on a Rural Economic Development project.

GEORGE SLATER, formerly economist for Allis-Chalmers Corporation in Milwaukee, is now Vice-President of the Citizens National Bank, Decatur, Illinois.

MELVIN W. SMITH accepted a position as Marketing Specialist with the Agricultural Extension Service, Auburn University, on July 1, upon completion of his Ph.D. at Ohio State University.

JAMES L. STALLINGS, formerly with New Mexico State University, has accepted a position with the Agricultural Adjustments Research Branch, Farm Economics Research Division, ARS, stationed at Lincoln, Nebraska. He will also teach a course in the Department of Agricultural Economics at the University of Nebraska.

S. D. STANIFORTH has been promoted to Professor of Agricultural Economics at the University of Wisconsin.

DAVID A. STOREY is joining the staff of the University of Illinois on August 1 as Assistant Professor, after completing his Ph.D. at Purdue University.

JAMES WILLETT TAYLOR received a summer appointment as Temporary Instructor at Kansas State University starting June 1. He is working with Professor W. H. Pine on a highway project.

D. WOODS THOMAS, Professor of Agricultural Economics at Purdue, will join the Purdue team at Rural University, Vicosa, Minas Gerais, Brazil, as agricultural economist starting the first of October.

ERIK THORBECKE has been promoted to Associate Professor in the Department of Economics and Sociology at Iowa State University (Ames).

T. R. TIMM, Head of the Department of Agricultural Economics and Sociology at Texas A. & M. College, was visiting professor early in the summer in the graduate school at Colorado State University lecturing on agricultural policy in the Regional Extension Graduate Program. He also spent a few days as

visiting professor at the Southern Methodist University Graduate School of Banking.

GERHARD TINTNER, Professor of Economics at Iowa State University (Ames), has been requested by the United Nations to spend June, July, and August in India as a technical consultant.

JONATHAN S. TOBEY was appointed Assistant Professor at Cornell on July 1. He will be responsible for extension work in poultry marketing and farm management. He was formerly with the Quaker Oats Company.

HARRY C. TRELOGAN, Assistant Administrator, Agricultural Marketing Service, received on May 17 a USDA Distinguished Service Award for vision and leadership in developing research to solve dynamic and complicated marketing problems during a period of extensive transition in marketing organization and practices.

RAPHAEL TRIFON has been promoted to Associate Professor in the Department of Agricultural Economics at the University of Manitoba.

ALEX H. TURNER was appointed Director of the Economics Division of the Canada Department of Agriculture on April 1. He was previously Vice-Chairman of the Agricultural Stabilization Board and Chief of the Marketing Section of the Division.

WARREN VINCENT has been promoted to Professor at Michigan State University.

FRANCIS WALKER was appointed Assistant Professor of Agricultural Economics at Purdue University on July 1. He recently completed his Ph.D. program at the University of Illinois.

THOMAS DUDLEY WALLACE will join the staff of the Department of Agricultural Economics at North Carolina State College as Assistant Professor in September.

HERBERT M. WALTERS transferred from the Milk Production and Utilization Section, Dairy Statistics Branch, Agricultural Estimates Division, AMS, on June 1, to be in charge of the Office of the State Statistician at Trenton, New Jersey.

T. KELLEY WHITE, JR., will join the staff of the Department of Agricultural Economics at North Carolina State College as Instructor in September.

CHARLES A. WILMOT has resigned as Assistant Professor of Agricultural Economics at the University of Arizona to accept a position as Economist, Fibers Section, Marketing Research Division, Agricultural Marketing Service. He will continue to be located in Tucson.

JOHN C. WINTER, Transportation and Facilities Division, AMS, received a USDA Superior Service Award for meritorious leadership in the formulation and supervision of an effective research program to improve the transportation of agricultural commodities.

ARTHUR W. WOOD has been promoted to Associate Professor in the Department of Agricultural Economics at the University of Manitoba.

ANNOUNCEMENT

The Executive Committee of The American Farm Economic Association has given approval to a request of the Johnson Reprint Corporation, 111 Fifth Avenue, New York, to reproduce, in bound form, the unavailable volumes and issues of the *Journal of Farm Economics*. The Corporation proposes to initiate the program with the reprinting of Volumes 1-5 and to consider at a later date the reprinting of Volumes 6-8.

OBITUARY

L. A. VENNES, Associate Professor of Marketing and Extension Specialist in Agricultural Marketing at the University of Kentucky, died suddenly of a heart attack on March 5, 1960. He was in his thirtieth year at Kentucky and had contributed importantly to both the extension and the teaching programs in marketing and agricultural cooperation.

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